HIV and Rational risky behaviors: a systematic review of published empirical literature (1990-2013)

Marlène Guillon, Josselin Thuilliez

UNIVERSITÉ PARIS 1
PANTHÉON SORBONNE

Documents de Travail du
Centre d'Economie de la Sorbonne

CES Working Papers

HIV and Rational risky behaviors: a systematic review of published empirical literature (1990-2013)

Marlène GUILLON, Josselin THUILLIEZ

2015.65

Maison des Sciences Économiques, 106-112 boulevard de L'Hôpital, 75647 Paris Cedex 13
http://centredeconomiesorbonne.univ-paris1.fr/
ISSN : 1955-611X

HIV and Rational risky behaviors: a systematic review of published empirical literature (1990-2013)

Marlène Guillon* Josselin Thuilliez†

August 25, 2015

*Corresponding author. PhD candidate. Paris School of Economics - Paris 1 Panthéon Sorbonne University. 48 boulevard Jourdan, 75014 Paris. E-mail: marlene.guillon@univ-paris1.fr . Telephone: +33 1 43 13 63 14

†Tenured Researcher. CNRS - Paris 1 Panthéon Sorbonne University. 106-112, Boulevard de l'Hôpital. 75013 Paris. E-mail: josselin.thuilliez@univ-paris1.fr

Documents de Travail du Centre d'Economie de la Sorbonne - 2015.65

Abstract

Risky health behaviors have the negative effect - negative externality - of the individual being able to spread the disease to others. They thus represent a threat for the society and a tragedy for public health. The objective of this study is to inquire into the nature, extent and strength of the evidence for such risky behaviors for HIV/AIDS from an economic perspective. We aim at investigating the concept of risk or prevalence-elasticity of health behaviors in the case of HIV. We did an exhaustive review of published articles in French and English indexed in the databases PubMed, ScienceDirect and Jstor between 1 January 1990 to 31 December 2013. We searched for publications empirically investigating the risk or prevalence-elasticity of behaviors in the case of HIV/AIDS and performed a bibliometric and descriptive analysis of the dataset. Of the 12,545 articles that were screened, 189 (1.5%) full-text publications studied the risk-elasticity of health behaviors that are related to HIV/AIDS. Of these 189 articles, 167 (88.4%) were quantitative studies that empirically estimated the risk-elasticity, and 22 (11.6%) were qualitative studies. We found that 55.7% of the quantitative studies included at least a correlation between HIV risk and health behaviors that supports the concept of risk or prevalence-elasticity. Moreover, we identified articles that address the reverse causality problem between HIV risk and health behaviors, by using indirect HIV risk measures, to demonstrate the existence of a responsiveness of risk/preventive behaviors to HIV risk. Finally, an in-depth analysis showed seven out of ten articles using an objective measure of risk for HIV/AIDS gave strong support to prevalence-elasticity. However, only one of the ten articles established a direct measure of prevalence-elasticity while appropriately dealing with the reverse causation problem between objective HIV risk and preventive/risk behaviors. These results stress out the need to carefully monitor programs of risk behaviors' surveillance in the context of HIV becoming chronic, especially in sub-Saharan Africa where large scale HIV treatment policies are being implemented. More evidence is needed on the strength of rational risky behaviors to maximize the public health and economic impact of large scale HIV treatment or preventive policies. With this purpose, epidemiological surveillance programs could be paired with specific behavioral surveillance programs to better inform policy makers.

Keywords: HIV, Economic epidemiology, Prevalence-elasticity

JEL: I10, I11

1 Introduction

Since its outset in 1982, the Acquired Immunodeficiency Syndrome (AIDS) epidemic has triggered a large political commitment and behavioral response in both developed and developing countries. Evidence of adaptation in risk practices, such as a reduction in the number of sex partners, the increased use of condom or a reduction in needle sharing, have been reported as early as the early 1980's among high-risk groups, such as Men who have Sex with Men (MSM) and Injection Drug Users (IDU) in the United States (US) (McKusick et al., 1985; Stall et al., 1988; Becker and Joseph, 1988; Francis, 2008). Descriptive evidence of reduced risk practices is also available for sub-Saharan countries, such as Uganda (Green et al., 2006), where the reduction in the casual and multiple partnerships and the increase in condom use in the late 1980's and early 1990's permitted a large decrease in both incidence and prevalence.

Despite large prevention campaigns in the 1990's and the release of Highly Active Antiretroviral Therapy (HAART) in 1996, the prevalence kept rising. In response, the fight against Human Immunodeficiency Virus (HIV)/AIDS was set as part of the millennium development goal agenda in 2000. The objective was to curb the growth of the epidemic by 2015. Despite a large amount of funding and significant advances in medical treatments and prevention strategies, this objective is only halfway completed. Although the number of new infections decreased in the early 2010's, 2.1 million new infections occurred in 2013, and 35 million adults are still infected (2014 Joint United Nations Programme on HIV (UNAIDS) Global Report).

Antiretroviral treatments have been used since 1996 to delay progression to AIDS and death for HIV-positive patients. In 2011, the results of the HIV Prevention Trials Network (HPTN) 052 trial demonstrated the preventive effect of ARV (Antiretroviral) treatments that had been assumed for more than a decade (Cohen et al., 2012). The results of this trial showed a 96% reduction in new infections thanks to treatment, advocating the scaling up of ARV treatments. In addition to direct health benefits for patients, a larger diffusion of ARV treatments would therefore indicate a public health benefit by preventing secondary infections. However, by decreasing the cost of infection, the scaling up of ARV treatment could also lead to a relapse in the preventive behaviors. This relapse has been observed following the introduction of ARV treatments in the US in 1996 (Geoffard and Méchoulan, 2004). Such behavioral response has also been previously observed in the US among MSM following a prevention fatigue (Jamila K Stockman, 2004; Rowniak, 2009). In this context, the benefit that is associated with the scaling-up of ARV treatments in terms of a decreased number of new infections could be at least partly offset by a relapse in the preventive behaviors among the general population. In extreme scenarios, the number of new infections could increase after a larger diffusion of ARV treatments, similar to what has been modeled for the hypothetical release of a vaccine (Blower and McLean, 1994; Bogard and Kuntz, 2002). Therefore, large-scale HIV treatment policy, if implemented, should be carefully monitored, and the evolution of prevention among the general population should be at particular stake. To prepare the implementation of large-scale HIV treatment policies, information on the elasticity of prevention behaviors to the risk of infection - i.e. the measurement of how responsive a preventive behavior is to a policy or prevalence change - is therefore required.

Nevertheless, although infectious diseases, in particular HIV, are the primary cause of mortality worldwide, their dynamics are not yet well understood by economists (Philipson, 2000). Gersovitz and Hammer (2003, 2004) performed a critical analysis of how rational choices help to explain how people respond to infectious diseases: people maximize their well-being by choosing levels of prevention and therapy that are subjected to the constraints they face, the main constraint being the disease prevalence itself. This approach is close to the social-psychology theory which consider that individuals choose their level of health service use according to their state of readiness to behave including perceived susceptibility of contracting a certain disease (Rosenstock, 2005). The difference between the two approaches stands in the nature of the risk measure that is either subjective or objective in the case of prevalence. Prevalence-elastic behavior, wherein demand for protection is an increasing function of rising prevalence, is thus at the center of economic epidemiology, which is defined as the introduction of rational economic decision making into mathematical epidemiological models. The analysis of such behaviors helps to understand what people do and what difficulties may face government intervention. Indeed, private choices do not lead to socially optimal outcomes. A large body of literature has explored this idea theoretically (Arrow, 2004; Geoffard and Philipson, 1997; Bauch and Earn, 2004). If the decisions that are made by individuals are not rewarded, coordinated or encouraged by subsidies, taxes or non-market incentives, the decisions that are made will most likely be socially sub-optimal.

Risky health behaviors have the negative effect - negative externality -of the individual being able to spread the disease to others. They thus represent a threat for the society. Within the economic theory such behaviors have been considered as rational since Becker and Murphy (1988). However, until recently, an individual's prevention behavior was not incorporated into epidemiological models (Philipson and Posner, 1993). Geoffard and Philipson (1996) focused on HIV/AIDS and stressed the possibility of high-prevalence-elastic behaviors, proposing a method for estimating the risk preferences that can be tested empirically by epidemiological cohort surveys and survival analyses. These authors emphasize the difference between standard epidemiological and economic models. As the demand for protection is an increasing function of prevalence, the hazard rate from susceptibility to infection will be a decreasing function of the prevalence of the disease in economic models because the remaining susceptible individuals face a larger risk and increase protection. In contrast, these authors consider that this function of the disease will increase in standard epidemiological models. This article has led to a series of theoretical economic epidemiological analyses (Ahituv et al., 1996; Bloom and Associates, 2000; Auld, 2006; Francis, 2008). However, model predictions have not been tested systematically, and evidence is globally dispersed. Put differently, the main conclusions have not been synthesized in a single analysis.

The objective of this study is to inquire into the nature, extent and strength of the evidence for such risk and prevalence-elastic behaviors for HIV/AIDS. We first establish proofs for the existence of risk-elastic behaviors. We then turn to the specific concept of prevalence-elasticity. The prevalence-elasticity of preventive behaviors in the case of HIV can be defined as the evolution in percentage of a given preventive behavior following a one percent increase in HIV prevalence. A positive prevalence-elasticity indicates responsiveness in preventive behaviors. Compared to the initial increase in prevalence, this behavioral response can be more than proportional, leading to an elasticity value that is greater than one. In this case, preventive behaviors can be considered elastic, which is positive to constrain the epidemic when the prevalence is increasing but negative when the prevalence is decreasing, as complete elimination is far more difficult. As for risk-elastic behaviors, we describe the evidence on prevalence-elastic behaviors in the case of HIV. However, we also gather the available estimates for the value of the prevalence-elasticity.

A major issue in the measurement of risk or prevalence-elasticity is the problem of endogeneity bias. Indeed, preventive behaviors and HIV risk are linked through many pathways. If preventive behaviors are strengthened following an increase in HIV risk, the change in the preventive behaviors might itself influence the (perceived) HIV risk, leading to a reverse causality attenuation bias. Omitted variables are also at concern to estimate risk or prevalence-elasticity as changes in the preventive behaviors and (perceived) HIV risk might react to shared factors, such as the release of new treatments or prevention campaigns. Finally, measurement errors in the level of objective or perceived HIV risk can also affect the estimations of risk or prevalence-elasticity. We therefore further attempt to characterize barriers to the empirical testing of the theory.

The rest of this paper is organized as follows. Section 2 describes the search strategy and inclusion criteria that were used to select articles. Section 3 provides an analysis of the selected articles. Finally, Section 4 concludes and outlines the main policy implications.

2 Material and methods

2.1 Search strategy

We searched the following databases for publications from January 1, 1990 to December 31, 2013 in English and French: PubMed, ScienceDirect and JSTOR. As the goal of the study was to capture empirical evidence of prevalence-elastic behaviors in the case of HIV/AIDS in low-, middle- and high-income countries, the search terms did not include a list of country names. We organized the search terms into two categories: terms relating to objective or subjective risk of the infectious disease (prevalence, incidence, risk, perception and risk perception) and terms relating to health behaviors (prevention, treatment-seeking behaviors, responsiveness, economics, usage, willingness to pay, behavioral response, behavioral reaction, preventive and risky behaviors, and precautionary behaviors).

The risk search terms that were developed included not only objective measures of risk, such as the incidence and prevalence of the disease or the likelihood of seroconversion, but also subjective measures of risk, such as the perceived susceptibility, perceived severity or estimated likelihood of infection. Indeed, individuals might react not only to real risk but also to subjective risk if information on HIV risk is incomplete or incorrect. Given the large number of risk and prevention behaviors that are associated with HIV/AIDS (from condoms, needle sharing, and multiple partnerships, among others) we used general search terms for health behaviors in order to cover the largest range of preventive and risk behaviors.

To avoid missing important literature on the topic, we used alternate terms in the "health behaviors" category. The term "prevention" was used, as well as "preventive behaviors" and "precautionary behaviors". Articles investigating the adaptation of risk/prevention behaviors to the objective or subjective risk of HIV were sought out using different search terms, as "responsiveness", "behavioral response" or "behavioral reaction".

Every combination of search terms in both of the categories was entered in the search engine of the three databases with the associated words "HIV/AIDS". Through this automatic search, all of the articles including in their title or abstract the words "HIV/AIDS" and two keywords relating to health behavior and (subjective or objective) risk were included. Details of the search terms strategy are available in Table 1. The titles and abstracts of every study as detected through this method were then read and screened for inclusion through a procedure that is described in the following sub-section. In the selected articles, all of the interesting references were searched for and integrated in the analysis if they met the inclusion criteria. For the literature reviews that were detected through the automatic search, all of the references were reviewed, and articles meeting the inclusion criteria were added to the analysis.

We assumed that a rigorous study of HIV prevalence-elastic behaviors would likely be published in database-indexed journals; therefore, our literature review was primarily focused on peer-reviewed articles as opposed to the so-called "gray literature" (i.e., written material that is published but not widely accessible, such as from technical reports from government agencies or scientific research groups, working papers from research groups or committees and so-called "white papers"). We note nonetheless that there is not a large amount of "gray literature" on this subject.

Table 1: Search terms

Risk measure	Health Behaviors
Prevalence	Prevention
Risk	Treatment-seeking behaviors
Impact	Responsiveness
Incidence	Economics
Perception	Usage
Risk perception	Willingness to pay
	Intention
	Avoidance behavior
	Behavioral response
	Behavioral reaction
	Risky behaviors
	Preventive behaviors
	Precautionary behavior
	Vaccination behavior

2.2 Data review and exclusion criteria

The original searches from all of the databases were combined in a Zotero® library (Zotero® version 4.0, Roy Rosenzweig Center for History and New Media, Fairfax, Virginia, USA), and all of the duplicates were removed. References lacking abstracts or studies that were not accessible were excluded. The articles that were detected through an automatic search were then reviewed for inclusion. The search algorithm is provided in Figure 1.

In the first step, the articles were excluded based on topic (e.g., articles whose primary interest was not HIV/AIDS, medical literature on AIDS treatment or prevention research) after reading the title and abstracts. All of the articles that study the effect of a HIV risk measures on HIV risk/prevention behavior were eligible for inclusion.

The second step of the exclusion procedure was performed using the following exclusion criteria: theoretical articles modeling the link between HIV risk and behavior with no data analysis or empirical tests, articles looking for non-behavioral determinants of risk perception or objective risk, articles studying the behaviors of individuals under ARV treatment, articles that did not include a measure of behavior or a measure of objective/subjective risk and articles that used a risk behavior to measure the objective risk of the disease for obvious problems of reverse causality. For quantitative publications, articles that did not include statistical analysis of the link between risk and behaviors were excluded.

In the final step, we differentiated between qualitative and quantitative articles such that the results would be reported separately for both types of studies.

2.3 Bibliometric analysis

We performed a simple descriptive bibliometric analysis of this dataset to map the research that is available regarding the link between HIV risk and behavior. Relevant articles from Zotero® were placed in a series of Excel® tables. For each publication, data on the following categories were extracted and assessed by reading the full text: year of publication, author name(s), publication title, publication journal, type of study (quantitative/qualitative), design, population type, prevention/risk behavior studied, measure of subjective or objective risk, results, presence of reverse causality problem and treatment of reverse causality problem. We calculated frequency of the type of prevention/risk behavior studied, the type of risk measure used and the type of design.

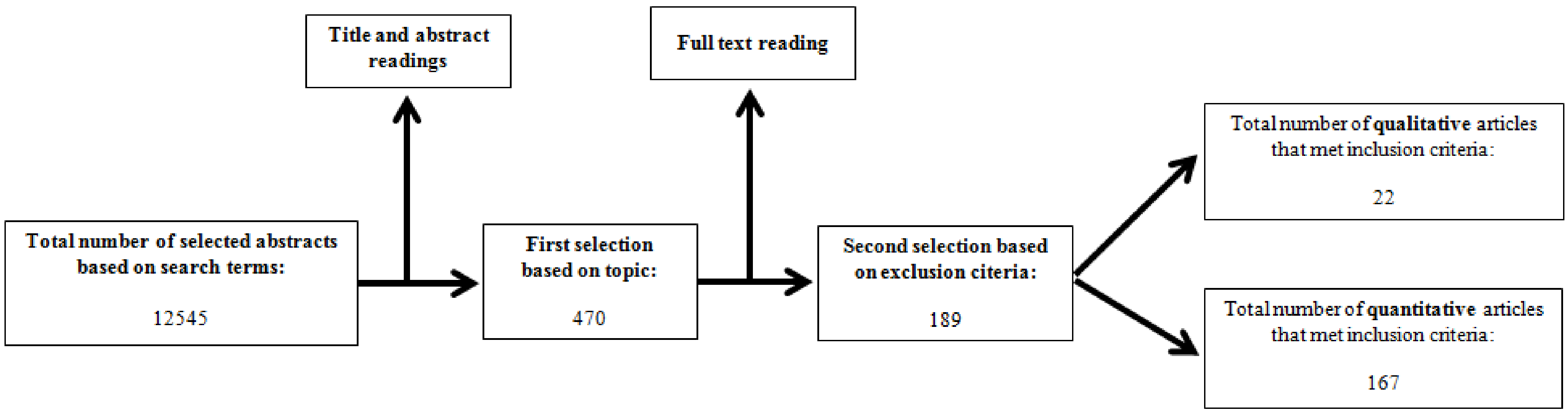
2.4 Searching empirical evidences of risk or prevalence-elasticity

When looking at the link between HIV risk and health behaviors, one cannot ignore the problem of reverse causality. Objective or subjective HIV risk measures might be associated with risk or prevention behaviors by increasing the (perceived) probability of infection. This rational adaptation of health behaviors to HIV risk translates into a negative correlation between risk behaviors and HIV risk or a positive correlation between preventive behaviors and HIV risk. However, risk and preventive behaviors of susceptible individuals also affect the spread of the disease and thus the objective HIV risk. Moreover, risk and preventive behaviors of susceptible individuals might also influence their subjective beliefs on HIV risk so that the reverse causality problem persists when subjective measures of HIV risk are used. According to this reverse causality effect, a positive correlation between risk behaviors and HIV risk should be observed while a negative correlation between preventive behaviors and HIV risk should be detected. A naive correlation measure between behaviors and HIV risk will capture both pathways of causality. However, as these two pathways produce opposite impacts, the sign of the correlation coefficient between HIV risk and health behaviors will indicate which effect dominates. In other words, since the presence of the reverse causality problem induces a downward bias in the measurement of the responsiveness of health behaviors to HIV risk, any positive (negative) correlation between HIV risk and preventive (risk) behaviors can be considered as supporting the concept of risk or prevalence-elasticity. In a first step we look at the sign of the correlation between HIV risk and health behaviors for qualitative and quantitative publications. For quantitative publications, we also check the significance of the correlation between the two variables. Articles were considered as supporting the concept of risk or prevalence-elasticity of health behaviors if they included a positive correlation between the risk measures and prevention behaviors or a negative correlation between the risk measures and risky behaviors.

Measuring the causal impact of HIV risk on health behaviors is challenging because of the simultaneity in the evolution of risk/preventive behavior and HIV objective or subjective risk measures. In a second step, we identify articles that addressed the reverse causality problem by using indirect measures of risk as econometric artifacts to demonstrate the existence of a responsiveness of risk/preventive behaviors to HIV risk. While these studies do not produce direct prevalence-elasticity estimates that could be used to better design public policies in the era of the fight against HIV/AIDS, they provide convincing proofs for the existence of risk-elastic behaviors.

In the third step of the analysis, we investigate the precise concept of prevalence-elasticity. To this end, we focus on studies using an objective measure of HIV risk such as incidence or prevalence. We start by describing the ten articles using an objective measure of HIV risk. In particular, we present the empirical strategy undertaken by the authors and the results they obtain. To determine whether derived empirical estimates establish a proof of the prevalence-elasticity concept, each article is screened for potential problems of endogeneity. In publications presenting such a problem, we determine whether the authors tried to develop an empirical strategy to treat problems of reverse causality or omitted variables. Finally, we discuss the scarce available evidence on the value of the prevalence-elasticity.

Figure 1: Search algorithm



3 Findings

3.1 Bibliometric results

Of 12,545 articles, 470 references (3.7%) were included in first step based on their topic of interest as determined through title or abstract readings. Of these 470 references, 189 (40.2%) met all of the inclusion criteria. Among these 189 publications, 167 (88.4%) could be classified as quantitative and 22 (11.6%) as qualitative. The list and details of the 167 quantitative publications is provided in the appendix.

We classified articles by the type of prevention/risk behavior studied, the type of risk measure used and the type of design. Among quantitative articles on HIV/AIDS, the most studied prevention behavior is condom use, which was the variable of interest in 47.9% of the articles. However, the range of HIV risk/prevention behaviors that were studied is very large. The studied behaviors ranged from sexual behaviors, such as abstinence or teen pregnancy, to drug-related behaviors, such as needle sharing. For qualitative publications on HIV/AIDS, the same pattern of distribution for the studied behavior was observed, as 50% of the qualitative articles studied condom use, and 31.8% considered multiple behaviors.

Three types of risk measures were used to classify the articles: objective risk measures, indirect risk measures and subjective risk measures. Objective risk measures included measures of prevalence, incidence or mortality rates. Subjective risk measures included perceived susceptibility and likelihood of infection, level of stress or anxiety as directly related to the disease or perceived severity and seriousness in the case of infection. Indirect measures of risk included all of the variables that could directly influence a person's perceived or objective risk of infection from the disease, such as the type of partner (casual vs. steady), the level of risk of partner, knowing someone who suffered or died from the disease or treatment-related beliefs. A total of 58.7% of the quantitative publications only used subjective risk measures, and 71.9% included at least one measure of risk that could be classified as subjective. The use of subjective risk measures might not be a problem, as people may adapt their behaviors based on their perception of the risk rather than the objective risk. However, this type of measure only describes risk-elasticity but not directly the prevalence-elasticity of the behaviors, as the perceived risk might differ from the objective risk due to a lack of information or perception bias. In contrast, only ten studies (6% of the total) used an objective measure of risk and could thus estimate elasticities that were close to prevalence-elasticities.

Regarding the type of design, we first differentiated experimental and non-experimental designs. Four studies used an experiment including three randomized control trials (Wilson et al., 2014; Gray et al., 2013; Dupas, 2011) and one quasi-experiment for program evaluation (Booth et al., 1999). One reference included in this list has been published in 2014 (Wilson et al., 2014). Considering the low number of randomized control trials on this topic, the corresponding 2012 working paper was initially included in the analysis because it was a randomized control trial. The article has been published meanwhile and we provide the final reference here. Non-experimental studies were classified as cohort, repeated cross-sectional, or cross-sectional studies. Cohort studies are studies that measure the risk and/or behaviors at several periods for the same individuals. Repeated cross-sectional studies also measure the risk and/or behaviors at several periods but for different individuals. Finally, cross-sectional studies include a one-time measure for risk and behavior. An overwhelming majority of the studies (79%) used a cross-sectional design. Cross-sectional studies establish a correlation between the risk measures and risk/prevention behaviors but often do not permit drawing conclusions about the causal impact of risk on behaviors if the endogeneity bias is not accounted for. Eight studies (4.8% of the total) used a repeated cross-sectional design, while twenty-one (12.6% of total) could be classified as cohort studies. We also found two literature reviews.

Table 2: Classification of articles by type of prevention/risk behavior studied, type of risk measure and type of design

Prevention / Risk Behavior studied			Risk measure			Type of design		
	Rank	N (%)		Rank	N (%)		Rank	N (%)
Quantitative			***Quantitative***			***Quantitative***		
Condom use	1	80 (47.9%)	Subjective	1	98 (58.7%)	Cross-sectional	1	132 (79%)
Multiple behaviors	2	43 (25.7%)	Indirect	2	39 (23.4%)	Cohort	2	21 (12.6%)
Risk Index	3	12 (7,2%)	Subjective / Indirect	3	20 (12%)	Repeated cross-sectional	3	8 (4.8%)
Drug related	4	7 (4.2%)	Objective	4	8 (4.8%)	Experimental	4	4 (2.4%)
Abstinence	5	6 (3.6%)	Subjective / Objective	5	2 (1.2%)	Literature review	5	2 (1.2%)
HIV risk	6	6 (3.6%)						
Number of sex partners	7	3 (1,8%)						
Fertility change	8	3 (1,8%)						
Circumcision	9	2 (1.2%)						
Female condom use	10	1 (0.6%)						
Microbicide use	11	1 (0.6%)						
Prostitution	12	1 (0.6%)						
Teen pregnancy	13	1 (0.6%)						
Abortion	14	1 (0.6%)						
Qualitative			***Qualitative***					
Condom use	1	11 (50%)	Indirect	1	12 (55%)			
Multiple behavior	2	7 (31.8%)	Subjective	2	9 (41%)			
Circumcision	3	1 (4.5%)	Objective	3	1 (5%)			
Microbicide use	4	1 (4.5%)						
Partner choice	5	1 (4.5%)						
Prostitution	6	1 (4.5%)						

3.2 Correlations between HIV risk and health behaviors

A positive correlation between risk measures and prevention behaviors or a negative correlation between risk measures and risky behaviors were classified as 1. “Link 1” articles point to a responsiveness of behaviors in front of risk that can be called “risk-elasticity” or “prevalence-elasticity” in the case of objective risk measures. The detailed results are provided in Tables A1 to A6.

A total of 93 quantitative articles (55.7% of total) depicted at least a significant correlation between risk/prevention behaviors and risk measures that points to a responsiveness of behavior to the level of risk. Among the experimental studies, two randomized control trials found no evidence of risk compensation after circumcision in Kenya (Wilson et al., 2014) or participation in a vaccine trial in South Africa (Gray et al., 2013), but one RCT in

Kenya found evidence of a behavioral response to information about objective risk among Kenyan girls (Dupas, 2011). One quasi-experiment aiming at the evaluation of an HIV-prevention program based on the Health Belief Model among homeless adolescents in the United States found a weak effect of subjective risk measures on behaviors in the absence of HIV knowledge (Booth et al., 1999). 43 quantitative articles (25.7% of all quantitative articles) included at least a correlation, indicating that risk perception or objective risk as measured by prevalence or incidence is influenced by risk and prevention behaviors. A total of 90.9% of the qualitative articles included at least a correlation indicating a responsiveness of behavior to risk.

3.3 Proofs of risk-elastic behaviors

Establishing evidence of risk-elastic behaviors is challenging because of the endogeneity between HIV risk and behaviors. To address the problem of reverse causality, some authors used an indirect measure of risk as econometric artifacts to demonstrate the existence of a responsiveness of risk/preventive behaviors to HIV risk. Although these indirect measures of risk allow for the establishment of proof regarding risk-elastic behaviors, they do not produce direct prevalence-elasticity estimates that could be used to better design public policies in the era of the fight against HIV/AIDS. In our review, 59 studies (35.4% of the total) used indirect measures of risk. These measures of risk could be classified into three main categories: studies that measured the respondent's level of risk by asking him/her whether (or how many) he/she knows someone that is infected with or who has died of HIV/AIDS, studies investigating risk-compensation following treatment release and studies analyzing risk behaviors depending on the relationship type. A few examples of these studies are provided in Table 3.

Using the first type of indirect risk measure, Moatti et al. (1991) investigated whether the use of condoms is related to knowledge of someone infected with HIV in a sample of 1008 men and women aged 18 to 44 years old in France. The results of this study indicate that women who know someone infected with HIV/AIDS are 95% more likely to use condoms compared to women who do not. Francis (2008) focused on sexual choices and how they depend on transmission and risk levels. Using a nationally representative dataset on sexuality in the

United States, Francis solved this reverse causality problem using a framework in which the change in sexual partners (movements along the heterosexual-homosexual margin) and having a relative with AIDS are exploited. This strategy enables an indirect estimate of risk-elastic behaviors. The author argues that having a relative with AIDS is negatively correlated with homosexuality in males but positively in females because those having a relative with AIDS have more HIV knowledge. Estimates confirm this theory: women who have a relative with AIDS are 6.2% more likely to say that they are not only sexually attracted to men. Men who have a relative with AIDS are 4.8% less likely to say that they are not only sexually attracted to women. Tenkorang et al. (2011) exploited longitudinal data of the Cape Area Panel Study in South Africa to determine whether risky sexual behaviors at the third wave (2005-2006) are influenced by knowing someone who has died of AIDS at baseline in 2002. After controlling for various socio-demographic and life-course variables, the authors show that knowing someone who had died of AIDS reduced by 76% the likelihood of transition to riskier sexual behaviors for men between the first and the third waves. For women however, knowledge of a person who had died of AIDS increased or had no effect on the probability of transition to riskier sexual behaviors.

Several studies examined the evolution of preventive/risk behaviors following the release of ARV treatments or depending on treatment-related beliefs. Geoffard and Méchoulan (2004) used repeated cross-sectional data of the "Stop AIDS Project" from 1994 to 2002 in San Francisco to determine whether the release of HAART in 1996 was associated with a relapse in preventive behaviors among gay men that were previously tested for HIV/AIDS. The rationale behind this empirical strategy is based on the fact that screening for HIV/AIDS is the gateway to HAART and thus reduces the cost of risky sexual behaviors when treatments are available. In the author's results, a dummy variable representing the apparition of HAART in 1996 was significantly associated with the probability of unprotected sexual intercourse among MSM that were previously tested for HIV/AIDS. The authors finally estimated that the release of HAART led to a 8.45% increase in the probability of unprotected anal intercourse among the studied population. Hart and Williamson (2005) as well as Cohen et al. (2009) studied the link between risk behaviors and treatment-related beliefs. Hart and Williamson used three cross-sectional surveys that were conducted between 1996 and 2002 in "gay" bars in Scotland to study whether unprotected anal intercourse in the last year is associated with treatment optimism. Using a multivariate analysis, the authors demonstrated that men who were "less worried about HIV infection now that treatments have improved" were respectively 38 and 74% more likely to engage in unprotected anal intercourse (UAI) with casual partners or with more than one partner compared to men who disagreed with this sentence. Cohen et al. use data from a survey on 1655 people who were aged 15 to 49 in Kenya to investigate whether HIV risk, as measured by HIV seroprevalence, is related to ART beliefs. Three ART factors were used by the authors to measure the ART beliefs and attitudes (details of these factors are provided in Table 4). The results of the authors demonstrate ART-related risk compensation and a belief that ART cures HIV are associated with an increased HIV seroprevalence in men but not women. In a multivariate analysis, after controlling for age, the authors found that ART-related risk compensation was especially associated with the increased prevalence of HIV among 15-24-year-olds, while the belief of a curative effect of ART was predominantly related to increased prevalence among 25-29-year-olds. It therefore seems that optimism about ARV treatments would lead to more risky sexual behaviors and a greater chance of becoming infected with HIV/AIDS.

The third type of study analyzed preventive/risk behaviors depending on the type of relationships and the estimated risk of partners. Steady partners might be perceived as less risky, and the use preventive behaviors might be less frequent with these partners. Gerber and Berman (2008) used panel data from a representative sample of Russian households to examine the relationship between condom use and the type or length of the relationship. The results demonstrate that condom use choices are linked to the nature and duration of the relationship with the sexual partner. Indeed, controlling for various socio-demographic and behavioral characteristics, multivariate logistic regression results indicate that condom use is more frequent in casual encounters, in those involving new partners or in those with commercial sex workers compared to encounters that are made in marital relationships. Condom use also decreases with the length of the relationship, as the rate of condom used is reduced in relationships longer than a month compared to relationships of less than a month. Using an experimental design, Dupas (2011) evaluated the effect of information about risk on sexual behaviors of adolescents in Kenya. Of 328 primary schools, 71 were randomly selected to benefit from another prevention program based on providing information on the relative risk of HIV infection by a partner's age. The incidence of teen pregnancy was used as an objective proxy for unprotected sex in female adolescents. The results of the program evaluation show that female adolescents seem to adapt their sexual behaviors to new information about risk. Indeed, the prevention program based on information led to a 28% decrease in teen pregnancy that arose from a substitution from risky older sex partners to same-age partners that were less likely to be infected with HIV.

Table 3: Examples of studies using indirect risk measures

Reference	Country	Population	Risk/prevention behavior (Dependent variable)	Indirect risk measure (explanatory variable)	Study type
Cohen and colleagues	Kenya	General population (15-49)	HIV seroprevalence	HIV is more controllable since ART (factor 1) ART-related risk compensation (factor 2) Belief that “ART Cures HIV/AIDS” (factor 3)	Cross-sectional
Dupas	Kenya	Female adolescents	Teen pregnancy	Evaluation of a HIV prevention program based on information about HIV prevalence by age in the region	Experimental (RCT)
Francis	USA	General population (18-59)	Same sex partner in last 5 years Appeal of sex with same gender Attraction to not only opposite sex Homosexual or bisexual identity	Having a relative with AIDS	Repeated cross-sectional
Goeffard and Méchoulan	USA (San Francisco)	MSM	Probability of unprotected anal intercourse (UAI)	Apparition of HAART in 1996: Dummy variable equal to 1 for years after 1996	Repeated cross-sectional
Gerber and Berman	Russia	Representative sample of households	Probability of condom use	Nature of the relationship : friend, spouse or acquaintance Duration of the relationship: <1 month, 1-12 months or >1 year	Cohort
Hart and Williamson	Scotland	MSM	UAI with: Casual partners More than 1 partner	Treatment optimism : Optimism 1: “I am less worried about HIV infection now that treatments have improved’” Optimism 2: “I believe that new drug therapies make people with HIV less infectious”	Repeated cross-sectional
Moatti, Bajos, Durbec, Menard and Serrand	France	General population (18-44)	Condom use	Personal knowledge of a HIV carrier	Cross-sectional
Tenkorang, Maticka-Tyndale and Rajulton	South Africa	Young adults (14–22)	Risk index: condom use and number of sexual partners	Knowledge of a friend who has died of AIDS	Cohort

Table 3 (continued): Examples of studies using indirect risk measures

Reference	Empirical strategy	Point estimate	Interpretation
Cohen and colleagues	Multivariate logistic regressions stratified by sex	Factor 1: Men : 1.28; Women: 0.99 Factor 2: Men: 1.45**; Women: 1.08 Factor 3: Men: 2.14**; Women: 1.43	ART-related risk compensation and a belief that ART cures HIV were associated with an increased HIV seroprevalence in men but not women.
Dupas	Evaluation of program impact : difference in difference between treatment and control groups	Difference in difference estimate: -27.7*	The prevention program led to a 28% decrease in teen pregnancy.
Francis	Linear probability model stratified by sex	Men : -0.051**; Women : 0.024 Men : -0.050**; Women : 0.075** Men : -0.048**; Women : 0.062* Men : -0.040**; Women : 0.033	Men who have a relative with AIDS are 5.1% less likely to declare same sex partnership in the last 5 years. Men/women who have a relative with AIDS are 5.1%/7.5% less likely to declare appeal of sex with same gender. Men/women who have a relative with AIDS are 4.8% less likely/6.2% more likely to declare attraction not only to opposite sex. Men who have a relative with AIDS are 4% less likely to declare homosexual or bisexual identity.
Goeffard and Méchoulan	Multivariate linear model	0.123**	The release of HAART led to a 8.45% increase in the probability of unprotected anal intercourse among already tested MSM.
Gerber and Berman	Multivariate logistic regressions stratified by sex	Nature of relationship (Ref: friend) Men : spouse (-1.806***); acquaintance (0.749**) Women : spouse (-1.346***); acquaintance (1.281**) Duration of relationship (Ref <1 month) : Men: 1-12 months (-0.426**); >1 year (-0.844***) Women: 1-12 months (-0.679***); >1 year (-0.682****)	For both men and women condom use is less frequent in encounters made in marital/regular relationships and more frequent in casual encounters. Condom use decrease with length of relationship for both men and women.
Hart and Williamson	Multivariate logistic regressions	UAI with: Casual partners: optimism 1 : 1.38**; optimism 2 : 1.30 More than 1 partner : optimism 1 : 1.74** and optimism 2 : 1.03	Optimistic men were 38% more likely to engage in UAI with casual partners. Optimistic men were 74% more likely to engage in UAI with more than 1 partners.
Moatti, Bajos, Durbec, Menard and Serrand	Multivariate logistic model stratified by sex	Men: 1.39 Women: 1.95**	Condom use is more frequent among women (but not men) who personally know a carrier of HIV/AIDS.
Tenkorang, Maticka-Tyndale and Rajulton	Multivariate linear model stratified by sex	Men: 0.242*** Women: 1.33	Knowing a friend who had died of AIDS reduced by 76% the likelihood of transition to riskier sexual behaviors. No effect for women.

3.4 Proofs of prevalence-elastic behaviors

In the last step of the analysis, we investigate the precise concept of prevalence-elasticity. Thus, we focus on studies using an objective measure of HIV risk (incidence, prevalence) as these studies derive values closer to prevalence-elasticity estimates. In an in-depth analysis, seven out of ten articles using an objective measure of risk for HIV/AIDS gave support to the concept of prevalence-elasticity. However, only one of the ten articles established a direct measure of prevalence-elasticity while appropriately dealing with the reverse causation problem between HIV prevalence and protective/risk behaviors. A summary table of these studies is provided in Table 4.

The National Longitudinal Survey of Youth in the United States, shows that the propensity of young adults to use or adopt condoms over time is responsive to the level of AIDS prevalence (Ahituv et al., 1996). In 1988 and 1990, the authors found a positive correlation between condom use and AIDS prevalence. Elasticity estimates that were obtained by the authors for all men and women throughout the US territory indicate that a 1% increase in AIDS prevalence would produce a 8.48% increase in the probability of condom use. Moreover, the prevalence-elasticities of condom use for these periods are higher for specific risk groups, such as black single men in urban areas (point estimate of 0.1422 in 1990 compared to 0.1099 for all men at the same date) and in high-prevalence states (point estimate of 0.2170 for all men and women in high prevalence states in 1990). In the second step, the authors estimated the elasticity of condom use adoption with respect to AIDS prevalence. The rate of condom adoption became increasingly responsive to the level of prevalence throughout the 1990's and was greater for higher-risk groups (single men and black men in urban areas). In 1990, a 1% increase in AIDS prevalence indicated a 3.58% increase in the probability of adopting condom use for all men and women, while the response among black single men in urban areas was much larger, with a 7.28% increase in condom use for the same evolution of AIDS prevalence. If the results of the authors clearly provide a proof for the concept of prevalence-elasticity, the use of repeated cross-sectional data does not fully address the reverse causality problem. Therefore, it seems likely that condom use and condom use adoption prevalence-elasticities as measured by the authors are downward biased and do not reflect the extent of the behavioral response in the population.

Anglewicz and Clark (2013) also focused on condom use and exploited the 2004 and 2006 waves from the Malawi Longitudinal Study of Families and Health to estimate the effect of spousal HIV-related characteristics on actual condom use with a spouse or steady partner. The authors found that a partner's HIV testing and result did not influence subsequent condom use or acceptability for either men or women. This result indicates a lack of elasticity for risk behaviors with respect to the objective measure of risk in this context. The authors however warn about their inability "to establish causal relationships", as the use of a fixed effect model does not allow determining the timing of change between the dependent and independent variables.

Three articles using an objective measure of HIV risk studied the impact of the HIV epidemics on fertility in Sub-Saharan Africa. The actual fertility can be seen as a proxy for risky sexual behaviors, as this variable is directly correlated with the level of unprotected sexual contacts. However, changes in fertility at the time of the AIDS epidemic might not only reflect behavioral changes undertaken to avoid HIV infection. Indeed, changes in desired fertility might also arise in response to the increases of adults and children mortality rates. If prevalence-elastic behaviors can lower fertility through increased condom use, the income effect related to the rise of adult mortality can, on the contrary, increase the demand for children (Boucekkine et al., 2009). Moreover, increased children mortality due to mother-to-child transmission might produce a replacement effect, pushing to an increase in fertility when HIV prevalence increases. The HIV/AIDS epidemic plays contradicting effects on fertility and demand for contraception. Therefore, elasticities of fertility or contraceptive demand to HIV prevalence will be downward biased and will not provide accurate measures of prevalence-elastic preventive behaviors. Given the multiple pathways through which the HIV epidemic might influence fertility in developing countries, it is not surprising that the three articles studying this link obtain diverging results. Only one article provide a weak evidence for the prevalence-elasticity concept (Young, 2007).

Magadi and Agwanda (2010) used 2003 DHS (Demographic and Heath Survey) data in Kenya to estimate the effect of the HIV/AIDS epidemic on the desired and actual fertility among Kenyan women. The results of multilevel logistic regressions made by the authors show that, after controlling for education, child mortality experience, individual-level HIV/AIDS factors (including serostatus) and fertility determinants (marital status and use of contraception), there was no statistically significant association between a women's fertility and the cluster-level of HIV prevalence.

Boucekkine et al. (2009) used data from the UNPD (United Nations Population Division) on 39 Sub-Saharan countries to investigate the link between fertility and HIV prevalence. When controlling for adults and children mortality rates, the authors find no effect of HIV prevalence on fertility. To confirm this result, the authors also look at the effect of the HIV prevalence rate in 2000 on the prevalence of contraceptive use at the same date. Once again, HIV prevalence does not seem to influence contraceptive use except through its effect on adult mortality. Indeed, when controlling for the adult mortality rate, the coefficient on the HIV variable is statistically insignificant. However, this coefficient becomes positive and significant once the adult mortality rate is withdrawn from the regression as an independent variable.

Young (2007) used DHS data from 29 Sub-Saharan countries to study the effect of HIV prevalence on fertility. Controlling for country-specific characteristic and time trends, the author highlights a negative correlation between the HIV prevalence and the desired and realized levels of fertility among women. These results are confirmed by the analysis of the contraception use among married women. Once country-specific characteristics and time trends accounted for, the HIV prevalence rate still exerts a positive and significant impact on the the use of condoms. However, as the use of other non-HIV protective contraceptives also increases with HIV prevalence, the positive association between condom use and HIV prevalence is likely to measure the change in the desired fertility rather than the adaptation of preventive behaviors to HIV risk.

Medoff (2012) used US state-level data on abortion rates and accumulated AIDS prevalence from 1981 to 2005 to determine whether a "women's unprotected sexual activity is deterred by the risk of contracting AIDS". After controlling for women's socioeconomic characteristics, state abortion laws, abortion prices and state/time-fixed effects, the author find that the risk of contracting AIDS, as measured by the AIDS prevalence, had a strong negative and significant impact on the demand for abortion (point estimate of -0.0014 significant at a 1% level). From the regression results, the author calculated the elasticity of abortion demand with respect to AIDS prevalence and estimated that a 10% increase in AIDS prevalence would lead to a 7% decrease in abortion rates. The use of the abortion rate as the dependent variable allowed the author to address the problem of reverse causality, as the rate of abortion in a state is directly linked to risky sexual behaviors but does not directly influence AIDS prevalence. Thus, the measure of the abortion rate prevalence-elasticity derived by the author provides an indirect but strong evidence of the responsiveness of risk behaviors to the AIDS prevalence among American women. However, the use of the abortion rate as a proxy for unprotected sexual acts does not allow deriving a direct measure of prevalence-elasticity of risk behaviors.

Two articles used the number or the existence of sex partners as measures of HIV risk behaviors. Auld (2006) attempted to measure the HIV prevalence-elasticity of the number of sex partners in gay men in San Francisco using data from the San Francisco Men's Health Study from June 1984 to August 1990. The results that were obtained by the author indicate that an increase in HIV prevalence implied a reduction in gay men's propensity to engage in risky partnerships. A 10% increase in prevalence implied a 4.6% decrease in the rate of partner change but almost no change in the propensity to participate in sexual activities. The author also differentiated the responsiveness of behaviors by the type of respondents, which were classified as either "high" or "low" activity types. Low-risk individuals exhibited higher elasticity for both types of behaviors. Indeed, a 10% increase in prevalence induced a 8.2% decrease in the rate of partner change and a 9.5% decrease in the probability of participation for individuals that were two standard deviations below the mean compared to a decrease of 1.1% and almost no change, respectively, for individuals two standard deviations above the mean. Even if this article represents the only attempt to measure prevalence-elasticities from disaggregated data, it suffers from several methodological problems, such as attrition in the sample leading to selection bias (which cannot be completely corrected for by the author), or the reverse causality problem. Indeed, because sexual behaviors, such as the number of sexual partners, directly influence the incidence and prevalence of HIV in this community measures of elasticities derived will suffer from a downward bias. Thus, if results of Auld (2006) provide a strong proof for the existence of prevalence-elastic sexual behaviors, they do not provide accurate values for prevalence-elasticities of the number of sex partners.

Lakdawalla et al. (2006) used the 1988 to 2002 waves of the GSS (General Social Survey) in the United States to study the effect of HAART release in 1996 on the sexual activity of HIV-positive individuals. While responsiveness of HIV-negative individuals to HAART was not the primary interest of the article, this hypothesis is tested by the authors. At the state-level, the authors investigate the relationship between the number of HIV-infected individuals benefiting from ARV treatment and the number of sex partners of uninfected adults (whose demographic characteristics are matched to the population of HIV-positive individuals). The number of infected individuals under treatment is used as a proxy for the HIV prevalence and is instrumented by the generosity of Medicaid eligibility rules. Indeed, at the time of the study, when no information on the preventive effect of antiretroviral treatment was available, antiretroviral treatments were viewed as increasing the life expectancy of HIV-infected individuals and thus HIV prevalence and HIV infection risk for susceptible individuals. Controlling for various region dummies and state-specific controls, the authors find that the generosity of Medicaid eligibility rules is significantly and negatively associated with the number of sex partners among a general sample of uninfected men and women but not among high-risk men (men who had sex with a prostitute in the last 12 months, who had a casual date in the last 12 months or who had ever paid for or having been paid for sex). Thus, only low-risk uninfected individuals seem to react to the increase in HIV prevalence by reducing the number of their sex partners. Results of Lakdawalla et al. (2006) provide a confident proof of sexual behaviors' responsiveness to HIV prevalence among low-risk individuals. However, the use of the Medicaid eligibility rules as an instrument for HIV prevalence does not allow drawing accurate estimates of behaviors' elasticities to HIV prevalence.

The remaining two articles focused on both condom use and the number of sexual partners. Godlonton and Thornton (2013) used the longitudinal data of the Malawi Diffusion and Ideational Change Project to measure the causal effect of other community members' testing on three individual risk behaviors (multiple partnership in the last year, condom use with current partner and condom use for any of the past three partners). The rationale behind this empirical strategy is that people tend to overestimate the prevalence of HIV and would, following a testing campaign in their village, revise these estimates downward. This decrease in risk perception would then lead to an increase in risk behaviors, such as multiple partnership or nonuse of condoms. The authors' theory was confirmed by their results on condom use but not by the number of sex partners. When 10% more community members learned their HIV results in 2004, individuals two years later were 38 percentage points less likely to use a condom with the current partner or to have used one with any of the last three partners. This effect is explained by a downward revision of the underlying prevalence in the community after the testing campaign. The longitudinal framework of the data allows the authors to estimate the effect of others' testing in 2004 on respondents' behaviors two years (2006) later while controlling for respondents' behaviors at the baseline (2004), which brings confidence in the establishment of a causal link between risk and behaviors. The elasticity of risk behaviors as measured by the authors cannot however be considered a direct prevalence-elasticity estimate.

Oster (2012) exploited data from DHS in 14 sub-Saharan countries between 2001 and 2007 to estimate the causal effect of the HIV epidemic on risk behaviors. Three risk behaviors were studied: the probability of multiple partnership, the number of sexual partners and the nonuse of condom with the last secondary partner. Oster chose to instrument the level of prevalence in a cluster using the cluster's distance to the viral origin of HIV in Congo. This strategy allowed the author to control for the reverse causality problem as showed by the difference in sign and magnitude of the correlation coefficients between prevalence and behaviors in OLS and IV regressions. OLS coefficients appeared to be positive for all but the number of sex partners for married individuals. Once the endogeneity of prevalence to sexual behaviors was controlled for, the IV estimators moved in the expected directions and exhibited a negative correlation between HIV prevalence and risk behavior. These results clearly speak in favor of prevalence-elastic risk behaviors, in particular among married individuals. As stated by the author, "the magnitude of the coefficients suggests that a doubling of HIV prevalence leads to, for married individuals, about a 1.8 percentage point decline in the chance of having multiple partners and about a 2 percentage points decline in having multiple partners without condom use".

The behavioral response to the epidemic appeared lower however among unmarried individuals. The IV coefficients on the three risk behaviors were indeed negative but much lower than those of married individuals and only marginally significant. The higher behavioral response among married men and women is puzzling as married individuals might be thought as a low-risk group for HIV infection. However, Ueyama and Yamauchi (2009) demonstrated that earlier marriage was used as an HIV risk reducing strategy among women in Malawi. If marriage is used as an HIV prevention strategy, married individuals form a special group of people whose behaviors are more responsive to HIV risk. It is then logical to find a higher elasticity of sexual behaviors to prevalence among married individuals. Moreover, the results obtained by the author are coherent with those of Auld (2006) and Lakdawalla et al. (2006) who demonstrate a higher prevalence-elasticity of risk behaviors among low-risk individuals. However, even among married individuals, the value of the elasticity of sexual behaviors to HIV prevalence appears as relatively low. In an attempt to explain this pattern, the author tried to introduce the life expectancy in the region as a moderating factor. Using either child mortality or climate-predicted malaria prevalence, the author demonstrated that part of the lack of behavioral response might be explained by high non-HIV mortality that deters the benefit of investment in HIV prevention.

This last article provide a strong evidence for the concept of prevalence-elasticity. Furthermore, it is the only article that established a direct measure of prevalence-elasticity while appropriately dealing with the reverse causation problem between objective HIV prevalence and risk behaviors.

Table 4: Summary table of in-depth analysis

Reference	Country	Population	Risk measure (explanatory variable)	Risk/prevention behavior (Dependent variable)
Ahituv, Hotz and Philipson	USA	Heterosexuals (25-27)	Accumulated number of AIDS cases/100,000 persons	Probability of condom use
				Probability of adopting condom use
Anglewicz and Clark	Malawi	Ever married women and their husbands	Spouse previously tested for HIV and received results	Condom use with spouse (ever)
Auld	USA	MSM (25-55)	HIV prevalence among MSM in San Francisco	6 months rate of partner change (log) Participation in risky sexual partnerships: Having 1 or more non monogamous partner
Boucekkine, Desbordes and Latzer	Sub-Saharan Africa	Women between (15-49)	HIV prevalence in the country in 2000	Contraceptive prevalence in 2000
Godlonton and Thronton	Malawi	Men and women (18+)	Proportion of those in individual i's village, j, who learned their HIV results since 2004	Multiple partnership last year (2006) Condom use with current partner Condom use for any of the past 3 partners

Table 4 (continued): Summary table of in-depth analysis

Reference	Study type	Elasticity measured	Point estimate	Interpretation	Risk-elastic behaviors	Problem of reverse causality
Ahituv, Hotz and Philipson	Repeated cross-sectional	Condom use elasticity (Men and women, all states, 1990)	0.0848*	A 1% increase in AIDS prevalence implies a 8.48% increase in the probability of condom use.	Yes	Yes: condom use influence the epidemic curve
		Condom use elasticity (Men and women, high prevalence states,1990)	0.2170*	A 1% increase in AIDS prevalence implies a 21.7% increase in the probability of condom use.	Yes	
		Condom use adoption elasticity (Men and women, all states, 1990)	0.0358*	A 1% increase in AIDS prevalence implies a 3.58% increase in the probability of adopting condom use.	Yes	
		Condom use adoption elasticity (Men and women, high prevalence states, 1990)	0.096	No responsiveness of condom use adoption in high prevalence states in 1990.	No	
Anglewicz and Clark	Cohort	Condom use elasticity (Men/Women)	0.92/0.75	Information on actual HIV status of the spouse do not change condom use in the couple.	No	Possible: the use of fixed effect model do not allow to establish the timing of change between the dependent and the independent variables
		Condom use elasticity (Women)	0.75			
Auld	Cohort	Elasticity of partner rate change	-0.46	A 10% increase prevalence implies a 4.6% decrease in the rate of partner change.	Yes	Yes
		Elasticity of participation in risky partnerships	-0.01	A 10% increase prevalence implies almost no change on the propensity to participate.	No	
Boucekkine, Desbordes and Latzer	Repeated cross-sectional	Elasticity of contraceptive use rate	0.01	No direct effect of HIV prevalence on contraceptive use once the indirect effect of HIV prevalence on contraceptive use through adult mortality is taken into account.	No	Yes
Godlonton and Thronton	Cohort	Elasticity of multiple partnerships	-0.008	No responsiveness of multiple partnerships to the increase in the community members learning their HIV status.	No	Partially treated through control for the same behaviors in 2004
		Elasticity of condom use with current partner	-0.382***	If 10% more community members learn their HIV results individuals are 38 percentage points less likely to use a condom with the current partner or to have used one with any of the last three partners.	Yes	

Table 4 (continued): Summary table of in-depth analysis

Reference	Country	Population	Risk measure (explanatory variable)	Risk/prevention behavior (Dependent variable)
Lakdawalla, Sood and Goldman	USA	Men and women	Number of HIV-positive individuals instrumented by Medicaid eligibility rules	Number of sex partners
Magadi and Agwanda	Kenya	Women (15-49)	Cluster-level HIV prevalence	Actual fertility as a proxy for unprotected sexual intercourses: recent birth
Medoff	USA	Women (15-44)	Cumulated number of reported AIDS cases per 1000 women in state s in period t	Abortion rate per 1000 women in state s in period t as a proxy for unprotected sexual intercourses
Oster	Sub-Saharan Africa	General Population	HIV prevalence (log) in the cluster instrumented by the cluster's distance to viral origin of HIV in Congo	Multiple partnership in the last year Multiple partnership and nonuse of condom with the last secondary partner
Young	Sub-Saharan Africa	Married women	HIV prevalence rate in the country	Use of contraception

Table 4 (continued): Summary table of in-depth analysis

Reference	Study type	Elasticity measured	Point estimate	Interpretation	Risk-elastic behaviors	Problem of reverse causality
Lakdawalla, Sood and Goldman	Repeated cross-sectional	Elasticity of number of sex partners	-0.0065***	An increase in the number of HIV-positive individuals under treatment. decreases the number of sex partners among susceptible individuals	No	Instrumentation of HIV prevalence by the generosity of Medicaid eligibility rules that determines the number of HIV-positive individuals benefiting from ARV treatments
		Elasticity of condom use with current partner	-0.382***	If 10% more community members learn their HIV results individuals are 38 percentage points less likely to use a condom.	Yes	
		Elasticity of condom use with any of the past 3 partners	-0.385***			
Magadi and Agwanda	Cross-sectional	Elasticity of fertility	-0.38	No evidence of association between cluster-level HIV prevalence and fertility.	No	No but several channels between fertility and HIV prevalence: HIV prevalence can increase fertility through replacement effect
Medoff	Repeated cross-sectional	Elasticity of abortion rate to AIDS prevalence	-0.78**	A 10% increase in AIDS prevalence implies a 7.8% decrease in abortion rate.	Yes	The abortion rate does not directly influence the AIDS prevalence
Oster	Cross-sectional	Semi-elasticity of multiple partnerships (Married individuals)	-0.0211***	A doubling of HIV prevalence leads to a reduction of 2.1 percentage points in the chance of having multiple partners for married individuals.	Yes	Treated through IV regression: Prevalence of HIV in the cluster instrumented by the distance between the cluster and the origin of the virus in the center of Congo
		Semi-elasticity of multiple partnerships (Unmarried individuals)	-0.0101*	A doubling of HIV prevalence leads to a reduction of 1 percentage point in the chance of having multiple partners for married individuals.	Yes	
		Semi-elasticity of condom use with last secondary partner (Married individuals)	-0.0253***	A doubling of HIV prevalence leads to a decrease of 2.5 percentage points in the chance of having multiple partners without condom use for married individuals.	Yes	
		Semi-elasticity of condom use with last secondary partner (Unmarried individuals)	-0.017***	A doubling of HIV prevalence leads to a decrease of 1.7 percentage points in the chance of having multiple partners without condom use for married individuals.	Yes	
		Semi-elasticity of number of non-marital partners (Married individuals)	-0.0436***	A doubling of HIV prevalence leads to a decrease of 4.3 non-marital sex partners for married individuals.	Yes	
		Semi-elasticity of number of non-marital partners	-0.0095	HIV prevalence do not influence the number of non-marital sex partners for unmarried individuals.	No	
Young	Repeated cross-sectional	Elasticity of contraceptive use	5.06***	Each 0.01 percent increase in the fraction of the population infected with HIV increases the ln probability of a married woman to use condoms (compared to no use of contraception) by 5.06%.	Yes	Condom use of married women might influence the HIV prevalence

4 Discussion

The circular causality between a disease risk and preventive/risk behaviors has been the purpose of numerous theoretical analyses, the majority of which investigated HIV. A central concept in rational epidemics is the so-called prevalence-elastic behavior of the individual demand for prevention, i.e., the measurement of how responsive prevention is to a change in the prevalence of disease. In this sense, an agents' preventive behavior may play an important role in disease dynamics and consequently in control strategies. A positive prevalence-elasticity indicates a decrease in the risk of illness prompts a decrease in prevention or treatment behaviors, leading in turn to a fresh increase in risk and consequently so-called "rational" epidemics (Philipson, 2000; Thuilliez and Berthélemy, 2014). Large scale HIV treatment or prevention programs, by decreasing the anticipated cost of infection, might trigger a rational increase in risky behaviors among the general population, especially in sub-Saharan Africa where treatment initiation criteria are currently being extended. The value of the risk or prevalence-elasticity may therefore influence the success and failure of disease control programs and the population response to such programs (less than proportional, proportional or more than proportional). However, considering the impacts that such rational choices may have on the acceptance and design of public policies, it is surprising that the available empirical evidence is relatively weak. More evidence is needed on the nature, extent and strength of rational risky behaviors to maximize the public health and economic impact of large scale HIV treatment or preventive policies.

Establishing clear empirical estimates of risk or prevalence-elasticity in the case of infectious diseases, especially HIV/AIDS, is challenging because of the mutual influence of risk/preventive behaviors and HIV risk. The simultaneous implementation of control programs might also influence behavioral responses to the epidemics and bias risk or prevalence-elasticity estimates. The objective of this study was to inquire into the nature, extent and strength of the evidence for such risk and prevalence-elastic behaviors for HIV/AIDS. We conducted an exhaustive literature review and found 189 articles dealing with the concept of risk or prevalence-elasticity. We identified 167 quantitative publication dealing with risk or prevalence-elasticity of which 55.7% gave support to this concept. We first tried to establish proofs for the existence of risk-elastic behaviors. To this end, we identified articles that addressed the reverse causality problem by using indirect measures of risk. While these studies do not produce direct prevalence-elasticity estimates that could be used to better design public policies in the era of the fight against HIV/AIDS, they provide strong evidences for the existence of risk-elastic behaviors. We then turned to the precise concept of prevalence-elasticity. We found ten quantitative studies using an objective measure of HIV risk that could derive values close to prevalence-elasticity estimates. Among these ten studies, seven gave support to the concept of prevalence-elasticity and five established confident proofs of its existence among MSM, hetersoxeual men and women in the US as well as heterosexual men and women in sub-Saharan Africa (Ahituv et al., 1996; Auld, 2006; Lakdawalla et al., 2006; Medoff, 2012; Oster, 2012). However, we only found one paper appropriately dealing with the reverse causality problem while simultaneously providing a direct estimate of prevalence-elasticity (Oster, 2012). The results indicate a relatively low adaptation of behaviors to HIV prevalence as a doubling prevalence would imply, among married individuals, a respective decline of only 2.1, 2.53 and 4.36% in multiple partnerships, the nonuse of condoms with the secondary partner and the number of non-marital partners. This results suggests a positive but less-than-proportional response to the epidemics, possibly permitting the control (or elimination) of the disease by scaling-up efficient treatment. Nevertheless, Oster showed that the apparent lack of behavioral response to the AIDS epidemic in Sub-Saharan Africa can be explained by high mortality rates in this region. Indeed, elasticity estimates obtained by the author increased when non HIV-related mortality rates were considered in the analysis. This finding could explain why studies from Anglewicz and Clark (2013), Boucekkine et al. (2009) and Magadi and Agwanda (2010), which all focused on sub-Saharan countries, found no evidence of responsiveness of health behaviors to HIV risk or prevalence. Oster's results also shed light on the complementarity between different types of health policies in Sub-Saharan Africa. Indeed, policies aiming at fighting malaria or improving access to primary care could have large and positive external effects on HIV prevention, suggesting that multiple diseases or crossed-morbidity prevalence-elasticities could be alternative ways to explore this question.

The study of the ten articles using an objective measure of HIV risk also demonstrated that looking at average elasticities might be misleading in terms of policy implication, as there seems to exist a large heterogeneity in behavioral responses across groups. Sub-group analyses could probably be more informative to asses the impacts that risk or prevalence-elastic behaviors may have on the acceptance and design of HIV control programs. Indeed, Ahituv et al. (1996), Auld (2006), Lakdawalla et al. (2006) as well as Oster (2012) showed that the elasticity of preventive/risk behaviors to prevalence may vary across individuals based on their initial level of risk. Ahituv et al. (1996) found that the elasticities of condom use and condom use adoption in the US were higher for risk groups, such as single men, black men or men living in urban areas. On the contrary, the three other articles demonstrated a higher prevalence-elasticity of behaviors among low-risk groups. Auld (2006) differentiated "high" and "low" activity types and showed that individuals whose participation and partner-change rates are low at baseline exhibit higher elasticities for both types of behaviors, with very-low–risk types exhibiting a rate of partner change and participation elasticities close to one. Lakdawalla et al. (2006) found a reduction in the number of sex partners among low-risk individuals but not high-risk individuals following the release of HAART in the US in 1996. Finally, Oster (2012) found a lower behavioral response to the HIV epidemic appeared among unmarried individuals compared to married individuals in sub-Saharan Africa. These results stress out the benefit of adapting prevention policies, aiming at fighting either "prevention fatigue" or risk compensation following the greater diffusion of ARV treatments, to specific groups based on their level of exposure to the disease.

Through an exhaustive literature review, we collected strong empirical evidence for the existence of prevalence-elastic behaviors in the case of HIV. However, given the circular causality between risk/preventive behaviors, very few studies derive estimates of prevalence-elasticity that are needed to design HIV control policies. New studies are therefore needed to obtain precise measures of HIV prevalence elasticity. These studies should preferably use objective measures of risk and cohort designs to tackle the endogeneity bias between risk and behaviors. Moreover, these studies should pay attention to contextual factors that might limit the behavioral response to HIV risk. Finally, further analyses on HIV prevalence-elasticity should be group-specific as responsiveness to HIV risk might differ by initial risk levels.

Appendix A: Eligible studies found through the automatic search

Table A1

Reference	Design	Country	Population	Health behavior	Risk measure	Link 1	Link 2	Reverse causality
Adedimeji et al. (2007)	Cross-Sectional	Nigeria	Youths	Risk index	Subjective	No	No	Yes
Adefuye et al. (2009)	Cross-sectional	USA	Students	Multiple behaviors	Subjective	No	Yes	Yes
Adegun et al. (2013)	Cross-sectional	Nigeria	Patients of clinic	Multiple behaviors	Subjective	Yes	No	Yes
Adih and Alexander (1999)	Cross-Sectional	Ghana	Adolescents	Condom use	Subjective	Yes	No	Yes
Ahituv et al. (1996)	Repeated cross-sectional	USA	Heterosexuals (25-27)	Condom use	Objective	Yes	No	Yes
Akwara et al. (2003)	Cross-Sectional	Kenya	General population	Risk index	Subjective	No	Yes	Yes
Amadora-Nolasco et al. (2002)	Cross-Sectional	Philippines	360 male IDUs	Drug related	Subjective	No	Yes	Yes
Anderson et al. (2007)	Cohort	South Africa	Youths	Abstinence	Subjective	Yes	Yes	Yes
Anderson et al. (1996)	Cross-Sectional	USA	Women (15–44)	Condom use	Subjective/Indirect	No	No	Yes
Anglewicz and Clark (2013)	Cohort	Malawi	Adults	Condom use	Subjective/Objective	Yes	No	Yes
Aspinwall et al. (1991)	Cohort	USA	MSM	Multiple behaviors	Subjective/Indirect	Yes	No	No
Auld (2006)	Cohort	USA	MSM	Multiple behaviors	Objective	Yes	Yes	Yes
Ayiga and Letamo (2011)	Cross-Sectional	Botswana	Men (15+)	Condom use	Subjective/Indirect	Yes	Yes	Yes
Bajos et al. (1997)	Cross-Sectional	France	Adults	Multiple behaviors	Subjective/Indirect	Yes	No	Yes
Baker et al. (1995)	Cross-Sectional	USA	Adults	Condom use	Indirect	Yes	No	No
Barden-O'Fallon et al. (2004)	Cross-sectional	Malawi	Men and women (15-44)	Multiple behaviors	Subjective	No	Yes	Yes
Benthin et al. (1993)	Cross-Sectional	USA	High school students	Abstinence	Subjective	Yes	No	Yes
Ben-Zur and Reshef-Kfir (2003)	Cross-Sectional	Israel	High school students	Multiple behaviors	Subjective	No	No	Yes
Ben-Zur (2003)	Cross-Sectional	Israel	Adolescents	Risk Index	Subjective	Yes	No	Yes
Biglan et al. (1990)	Cross-Sectional	USA	High school students	Multiple behaviors	Indirect	No	Yes	No
Booth et al. (1999)	Quasi-experiment	USA	Homeless Adolescents	Multiple behaviors	Subjective	Yes	Yes	Yes
Borgdorff et al. (1994)	Cross-Sectional	Tanzania	Men (15-45)	Condom use	Indirect	Yes	No	No
Boucekkine et al. (2009)	Repeated cross-sectional	Sub-Saharan Africa	General population	Fertility change	Objective	Yes	No	No
Boulle et al. (2010)	Cross-Sectional	South Africa	Adults (14-49)	Condom use	Indirect	Yes	No	Yes
Brown and Van Hook (2006)	Cross-sectional	USA	African American drug user women	Multiple behaviors	Subjective	No	No	Yes
Cabieses et al. (2010)	Cross-Sectional	Chile	Community clinic workers	Risk index	Subjective	No	No	Yes
Catania et al. (1992)	Cross-Sectional	USA	Men and women (20-44)	Condom use	Subjective	No	No	Yes
Catania et al. (1994)	Cohort	USA	Adults (20-45)	Condom use	Indirect	Yes	No	No
Catania et al. (1993)	Cohort	USA	Adults	Condom use	Indirect	Yes	No	No
Chao et al. (2007)	Cross-Sectional	South Africa	Teachers	Condom use	Subjective	Yes	No	No

Table A2

Reference	Design	Country	Population	Health behavior	Type of risk measure	Link 1	Link 2	Reverse causality
Chelenyane and Endacott (2006)	Cross-sectional	Botswana	Nurses	Multiple behaviors	Subjective	No	No	Yes
Cohen and Bruce (1997)	Cross-Sectional	USA	Students	Multiple behaviors	Subjective	No	No	No
Cohen et al. (2009)	Cross-Sectional	Kenya	Adults (15–49)	HIV risk	Subjective	Yes	No	No
Crisp and Barber (1995)	Cross-Sectional	Australia	Incarcerated IDUs (14-21)	Multiple behaviors	Subjective	No	Yes	Yes
Da Silva et al. (2005)	Cross-Sectional	Brazil	MSM	Condom use	Subjective	Yes	No	Yes
de Souza et al. (1999)	Cross-sectional	Brazil	MSM	Condom use	Subjective	No	Yes	Yes
Do and Meekers (2009)	Cross-sectional	Zambia	General Population	Number of sex partners	Subjective	No	Yes	Yes
Dolcini et al. (1993)	Cross-Sectional	USA	Adults (18-60)	Condom use	Indirect	Yes	No	No
Dudley et al. (2002)	Cross-Sectional	USA	Latino girls (13-18)	Multiple behaviors	Indirect	No	Yes	Yes
Dupas (2011)	Experimental (RCT)	Kenya	Adolescents	Teen pregnancy	Indirect	Yes	No	No
Ellen et al. (1996)	Cross-sectional	USA	Teenagers	Multiple behaviors	Subjective	No	No	Yes
Ellen et al. (2002)	Cohort	USA	Adolescents	Condom use	Subjective	Yes	No	No
Essien et al. (2008)	Cross-Sectional	Mexico	Mexican American adults	Drug related	Subjective	No	Yes	Yes
Finer et al. (1999)	Cross-Sectional	USA	Women	Condom use	Indirect	Yes	No	No
Fisher et al. (2008)	Cross-Sectional	USA	Adolescents (12–17)	Multiple behaviors	Subjective/Indirect	No	Yes	Yes
Flaskerud et al. (1996)	Cross-Sectional	USA	Hispanic women	Multiple behaviors	Subjective	No	No	Yes
Fortenberry et al. (2002)	Cohort	USA	Women (13–22)	Condom use	Indirect	Yes	No	No
Francis (2008)	Repeated cross-sectional	USA	Adults (18-59)	Multiple behaviors	Subjective	Yes	No	Yes
Galavotti et al. (1995)	Cross-Sectional	USA	High-risk women	Condom use	Indirect	Yes	No	No
Gavin et al. (2006)	Cross-Sectional	Zimbabwe	Adolescent Females	HIV risk	Subjective	Yes	No	No
Geoffard and Méchoulan (2004)	Repeated cross-sectional	USA	MSM	Condom use	Indirect	Yes	No	No
Gerber and Berman (2008)	Cohort	Russia	Households	Condom use	Indirect	Yes	No	No
Geringer et al. (1993)	Cross-sectional	USA	Adults (14-52)	Condom use	Indirect	Yes	No	No
Gerrard et al. (1996)	Literature review	USA, Netherlands Australia, Canada	College students, MSM Adolescents, Drug users	Multiple behaviors	Subjective	Yes	Yes	Dependent on study
Godlonton and Thornton (2013)	Cohort	Malawi	General population	Multiple behaviors	Objective	Yes	No	No
Goldman and Harlow (1993)	Cross-Sectional	USA	College students	Risk Index	Subjective	No	Yes	Yes
Gómez and Marín (1996)	Cross-Sectional	USA	Latino women	Condom use	Subjective	Yes	No	Yes
Gorman and Bohon (2001)	Cross-Sectional	USA	Women	Condom use	Subjective	Yes	No	No
Grappasonni et al. (2011)	Cross-Sectional	Italy	Seafarers	Condom use	Indirect	Yes	No	No
Gray et al. (2013)	Experimental (RTC)	South Africa	Adults (18-35)	Multiple behaviors	Indirect	No	No	No

Table A3

Reference	Design	Country	Population	Health behavior	Type of risk measure	Link 1	Link 2	Reverse causality
Gregson et al. (1998)	Cross-Sectional	Zimbabwe	Women	Multiple behaviors	Subjective	Yes	No	No
Gregson et al. (1997)	Cross-Sectional	Zimbabwe	Households	Multiple behaviors	Subjective	Yes	No	No
Gromet et al. (2010)	Cohort	USA	Juvenile offenders	Risk index	Subjective	No	No	No
Guiella and Madise (2007)	Cross-Sectional	Burkina Faso	Adolescents (12-19)	Condom use	Indirect	Yes	No	No
Han et al. (2009)	Cross-Sectional	China	Female Sex Workers	Microbicide use	Subjective/Indirect	Yes	No	No
Hansen and Hahn (1990)	Cross-sectional	USA	Men and women (18-25)	Multiple behaviors	Subjective	No	No	Yes
Hart and Williamson (2005)	Repeated cross-sectional	Scotland	MSM	Condom use	Indirect	Yes	No	Yes
Hingson et al. (1990)	Cross-Sectional	USA	Adolescents	Condom use	Subjective/Indirect	Yes	No	Yes
Hoque et al. (2009)	Cross-Sectional	Bangladesh	Rickshaw pullers (men)	Prostitution	Subjective	No	Yes	Yes
Iguchi et al. (2001)	Cross-Sectional	USA	Female sex partners of injecting drug users	HIV risk	Subjective	No	Yes	Yes
Iriyama et al. (2007)	Cross-Sectional	Nepal	Male adolescent students	Abstinence	Subjective	Yes	No	Yes
Jain et al. (2011)	Cross-sectional	India	Female sex workers	Condom use	Subjective	No	Yes	Yes
Jiang et al. (2013)	Cross-Sectional	China	Male Rural-to-Urban Migrant	Circumcision	Indirect	Yes	No	No
Kabiru and Orpinas (2009)	Cross-Sectional	Kenya	Male High School Students	Condom use	Subjective	No	No	Yes
Kalichman et al. (1992)	Cross-Sectional	USA	Women	Risk Index	Subjective	No	Yes	Yes
Kelly et al. (1990)	Cross-Sectional	USA	MSM	Condom use	Subjective	No	Yes	Yes
Kengeya-Kayondo and Carpenter (1999)	Cross-sectional	Uganda	Adults (> 13)	Multiple behaviors	Subjective	No	Yes	Yes
Kibombo et al. (2007)	Cross-Sectional	Uganda	Adolescents (12-19)	Risk index	Subjective/Indirect	No	Yes	Yes
Klein et al. (2003)	Cross-sectional	USA	Minority women	Multiple behaviors	Subjective	No	Yes	Yes
Kline and Strickler (1993)	Cross-sectional	USA	Women in drug treatment	Drug related	Subjective	No	Yes	Yes
Ku et al. (1994)	Cohort	USA	Male adolescents (15-19)	Condom use	Subjective/Indirect	Yes	No	No
Lakdawalla et al. (2006)	Repeated cross-sectional	High-risk adults	USA	Number of sex partners	Objective	Yes	No	No
Langer and Tubman (1997)	Cross-Sectional	USA	Substance abusing adolescents	Risk Index	Subjective	No	Yes	Yes
Laraque et al. (1997)	Cross-Sectional	USA	Adolescents	Condom use	Subjective	No	No	No
Lau et al. (2011)	Cross-Sectional	China	MSM	Circumcision	Subjective	Yes	No	Yes
Lau et al. (2004)	Cross-Sectional	Hong Kong	Men (18–60)	Condom use	Subjective/Indirect	No	Yes	Yes
Leigh et al. (1993)	Cross-Sectional	USA	Men and women (22-70)	Condom use	Subjective/Indirect	Yes	No	Yes
Lutalo et al. (2000)	Cross-Sectional	Uganda	General Population	Condom use	Subjective	Yes	No	Yes
MacKellar et al. (2007)	Cross-sectional	USA	Men (23-29)	Multiple behaviors	Subjective	No	Yes	Yes
Magadi and Agwanda (2010)	Cross-Sectional	Kenya	General Population	Fertility change	Objective/Indirect/Subjective	Yes	No	No

Table A4

Reference	Design	Country	Population	Health behavior	Type of risk measure	Link 1	Link 2	Reverse causality
Maharaj (2006)	Cross-Sectional	South Africa	Young people	Condom use	Subjective	No	Yes	Yes
Maharaj and Cleland (2005)	Cross-Sectional	South Africa	Couples	Condom use	Subjective	Yes	No	No
Maharaj and Cleland (2004)	Cross-Sectional	South Africa	Couples	Condom use	Subjective	Yes	No	No
Magura et al. (1994)	Cross-Sectional	USA	Criminally involved males (16-19)	Condom use	Subjective/Indirect	Yes	No	No
Marin and Marin (1992)	Cross-Sectional	USA	Hispanic adults (18-65)	Condom use	Indirect	Yes	No	No
Markosyan et al. (2007)	Cross-Sectional	Armenia	Female Sex Workers	Condom use	Subjective	Yes	No	Yes
Marston et al. (2004)	Cross-Sectional	Mexico	Men (15-60)	Condom use	Subjective/Indirect	Yes	No	Yes
Maswanya et al. (1999)	Cross-Sectional	Tanzania	Students	Multiple behaviors	Subjective/Indirect	Yes	No	Yes
Maticka-Tyndale (1991)	Cross-Sectional	USA	University student	Condom use	Subjective	No	No	Yes
Maticka-Tyndale and Tenkorang (2010)	Cross-Sectional	Kenya	Adolescents	Condom use	Subjective	No	No	Yes
McGrath et al. (2013)	Cohort	South Africa	Men and Women (17–54)	Multiple behaviors	Indirect	No	No	No
McKee et al. (1995)	Cross-sectional	Scotland	Male prisoners or male prison guards	Drug related	Subjective	No	Yes	Yes
Medoff (2012)	Repeated cross-sectional	USA	Women (15-44)	Abortion rate	Objective	Yes	No	No
Meekers and Klein (2002)	Cross-Sectional	Cameroon	Young People	Condom use	Subjective	Yes	No	No
Meekers and Richter (2005)	Cross-Sectional	Zimbabwe	Sexually active consumers	Female Condom use	Subjective	No	Yes	Yes
Miller et al. (2013)	Cross-Sectional	USA	Adolescents (14-17)	Multiple behaviors	Subjective	Yes	No	Yes
Mills et al. (2008)	Cross-Sectional	USA	Adolescents	Abstinence	Subjective	Yes	Yes	Yes
Millstein and Moscicki (1995)	Cross-Sectional	USA	Female adolescents (13-19)	Multiple behaviors	Subjective	No	No	Yes
Minichiello et al. (2001)	Cross-Sectional	Australia	Male Sex Workers	Condom use	Subjective	Yes	No	Yes
Misovich and Fisher (1996)	Cross-Sectional	USA	Undergraduate students	Condom use	Indirect	Yes	No	No
Mitchell and Latimer (2009)	Cross-sectional	USA	IDUs	Drug related	Subjective	No	Yes	Yes
Moatti et al. (1991)	Cross-Sectional	France	Men and Women (18-44)	Condom use	Subjective/Indirect	Yes	No	Yes
Moore et al. (1995)	Cross-Sectional	USA	Hispanic women	Condom use	Subjective	No	No	Yes
Muñoz et al. (2005)	Cross-Sectional	USA	Latino MSM	Condom use	Subjective/Indirect	Yes	No	Yes
Murphy et al. (1998)	Cross-sectional	USA	Teenagers (14-21)	Risk index	Subjective	No	Yes	Yes
Napper et al. (2012)	Cross-sectional	USA	Adults (18-79)	Multiple behaviors	Subjective	No	Yes	Yes
Njogu and Martin (2006)	Cross-sectional	Kenya	Young women and men	Condom use	Subjective/Indirect	Yes	No	Yes
Ntaganira et al. (2012)	Cross-sectional	Rwanda	Youths	Abstinence	Subjective	No	Yes	Yes
Ntozi and Kirunga (1997)	Cross-Sectional	Uganda	General population	Multiple behaviors	Indirect	Yes	No	Yes
Ober et al. (2011)	Cross-Sectional	USA	Low-Income Women	Condom use	Indirect	No	No	No

Table A5

Reference	Design	Country	Population	Health behavior	Type of risk measure	Link 1	Link 2	Reverse causality
Oster (2012)	Cross-Sectional	Sub-Saharan Africa	General Population	Multiple behaviors	Objective	Yes	No	No
Peterson et al. (1993)	Cross-Sectional	USA	Men and Women (18-49)	Condom use	Indirect	Yes	No	No
Pleck et al. (1991)	Cross-Sectional	USA	Adolescent Males (15-19)	Condom use	Subjective	Yes	No	Yes
Prata et al. (2006)	Cross-Sectional	Mozambique	General Population	Condom use	Indirect	Yes	No	Yes
Rácz et al. (2007)	Cross-Sectional	Hungary	IDUs	Drug related	Subjective	No	Yes	Yes
Puri and Cleland (2006)	Cross-sectional	Nepal	Migrant workers	Number of sex partners	Subjective	No	No	Yes
Raghubir and Menon (1998)	Cross-Sectional	Hong Kong	College students	Condom use	Subjective	Yes	No	Yes
Richard and Van Der Pligt (1991)	Cross-Sectional	Netherlands	School pupils (15-19)	Condom use	Indirect	No	No	Yes
Rimal et al. (2009b)	Cross-Sectional	Malawi	General Population	Condom use	Subjective	Yes	No	Yes
Rimal et al. (2009a)	Cross-Sectional	Malawi	Male adolescent	Multiple behaviors	Subjective	No	No	Yes
Rimberg and Lewis (1994)	Cross-Sectional	USA	College Students	Multiple behaviors	Subjective	Yes	No	Yes
Robertson et al. (2006)	Cross-Sectional	USA	African-American	Condom use	Subjective	No	No	Yes
Robles et al. (1995)	Cohort	Puerto Rico	IDUs	Drug related	Subjective	No	Yes	Yes
Rosenthal et al. (1992)	Cross-sectional	Australia	Students (17-20)	Condom use	Subjective/Indirect	No	No	Yes
Sabogal et al. (1993)	Cross-Sectional	USA	Men and Women (18-49)	Condom use	Indirect	Yes	No	No
Savasta (2004)	Literature review	USA	Adults over 50	HIV risk	Subjective	Yes	No	Yes
Singer et al. (1998)	Cross-sectional	USA IDUs	Multiple behaviors	Subjective	No	No	Yes	
Sohn and Jin (1999)	Cross-Sectional	Korea	Female Sex Workers	Condom use	Subjective	No	No	Yes
Soskolne and Maayan (1998)	Cross-Sectional	Israel	Women (14-30)	Condom use	Indirect	Yes	No	Yes
St Lawrence (1993)	Cross-Sectional	USA	African American	Condom use	Subjective	No	No	Yes
St Lawrence et al. (1995)	Cross-Sectional	Nigeria	Adolescents (13-19)	Condom use	Subjective	No	No	Yes
Steers et al. (1996)	Cross-sectional	USA	Students (17-22)	Multiple behaviors	Subjective	Yes	Yes	Yes
Stiffman et al. (1994)	Cohort	USA	Adolescents (13-18)	Condom use	Subjective	Yes	No	No
Stringer et al. (2004)	Cross-sectional	Zambia	Pregnant women	Risk index	Subjective No Yes Yes			
Sturdevant et al. (2001)	Cohort	USA	Women	Condom use	Indirect	Yes	No	No
Sutton et al. (1999)	Cross-Sectional	UK	English Young People	Condom use	Subjective	Yes	No	No
Tanfer et al. (1993)	Cross-Sectional	USA	Men (20-39)	Condom use	Indirect	Yes	No	No
Temple and Leigh (1992)	Cross-Sectional	USA	Adults	Condom use	Indirect	Yes	No	No
Tenkorang et al. (2011)	Cohort	South Africa	Youths	Multiple behaviors	Subjective/Indirect	Yes	No	No
Tenkorang et al. (2009)	Cohort	South Africa	Youths	Abstinence	Subjective/Indirect	Yes	No	No

Table A6

Reference	Design	Country	Population	Health behavior	Type of risk measure	Link 1	Link 2	Reverse causality
Trani et al. (2005)	Cross-Sectional	Italy	Adolescents	Condom use	Subjective	Yes	No	Yes
Ugarte et al. (2013)	Cross-Sectional	Nicaragua	General Population	Condom use	Subjective	Yes	No	No
Uitenbroek (1994)	Cross-Sectional	Scotland	Men and women (18-51)	Condom use	Indirect	Yes	No	No
Van der Snoek et al. (2005)	Cohort	Netherlands	MSM	HIV risk	Indirect	Yes	No	No
Van der Velde et al. (1992)	Cohort	Netherlands	Patients at STD clinic	Multiple behaviors	Subjective	No	No	No
Vanable et al. (2000)	Cross-Sectional	USA	MSM	Multiple behaviors	Indirect	Yes	No	Yes
Wagstaff et al. (1995)	Cross-Sectional	USA	Low-Income Women	Condom use	Indirect	No	No	No
Wang et al. (2007)	Cross-Sectional	China	Male and female migrants	Risk Index	Subjective	Yes	No	Yes
Weisman et al. (1991)	Cross-Sectional	USA	Women (11-19)	Condom use	Indirect	No	No	No
White (2004)	Cross-Sectional	Jamaica	Adolescents	Condom use	Subjective	No	No	Yes
Wilson et al. (2014)	Experimental (RCT)	Kenya	Men	Multiple behaviors	Indirect	No	No	Yes
Wim et al. (2013)	Cross-Sectional	Belgium	MSM	Condom use	Subjective	No	Yes	Yes
Wong and Tang (2004)	Cross-Sectional	China	MSM	Condom use	Subjective	Yes	No	Yes
Wood et al. (2005)	Cohort	Canada	IDUs	HIV risk	Subjective	No	Yes	No
Wulfert and Wan (1993)	Cross-Sectional	USA	College students	Condom use	Subjective	No	No	Yes
Young (2007)	Repeated cross-sectional	Sub-Saharan Africa	General population	Fertility change	Objective	Yes	No	No
Zimmerman and Olson (1994)	Cross-sectional	USA	College students	Multiple behaviors	Subjective	No	No	Yes

References

(2000). *The Economical Control of Infectious Diseases*. Policy Research Working Papers. The World Bank.

Adedimeji, A. A., Omololu, F. O., and Odutolu, O. (2007). HIV risk perception and constraints to protective behaviour among young slum dwellers in ibadan, nigeria. *Journal of health, population, and nutrition*, 25(2):146–157.

Adefuye, A. S., Abiona, T. C., Balogun, J. A., and Lukobo-Durrell, M. (2009). HIV sexual risk behaviors and perception of risk among college students: implications for planning interventions. *BMC Public Health*, 9:281.

Adegun, P. T., Adegoke, S. A., Solomon, O. S., and Ade-Ojo, I. P. (2013). Perception of personal risk of acquiring human immunodeficiency viral infection/acquired immune deficiency syndrome among people attending outpatient clinics in a teaching hospital of Nigeria. *Indian Journal of Public Health*, 57(2):96–99.

Adih, W. K. and Alexander, C. S. (1999). Determinants of condom use to prevent HIV infection among youth in ghana. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 24(1):63–72.

Ahituv, A., Hotz, V. J., and Philipson, T. (1996). The responsiveness of the demand for condoms to the local prevalence of AIDS. *The Journal of Human Resources*, 31(4):869–897. ArticleType: research-article / Full publication date: Autumn, 1996 / Copyright © 1996 The Board of Regents of the University of Wisconsin System.

Akwara, P. A., Madise, N. J., and Hinde, A. (2003). Perception of risk of HIV/AIDS and sexual behaviour in kenya. *Journal of biosocial science*, 35(3):385–411.

Amadora-Nolasco, F., Alburo, R. E., Aguilar, E. J. T., and Trevathan, W. R. (2002). Knowledge and perception of risk for HIV and condom use among male injecting drug users in cebu city, philippines. *Drug and Alcohol Review*, 21(2):137–143.

Anderson, J. E., Brackbill, R., and Mosher, W. D. (1996). Condom use for disease prevention among unmarried u.s. women. *Family planning perspectives*, 28(1):25–28.

Anderson, K. G., Beutel, A. M., and Maughan-Brown, B. (2007). HIV risk perceptions and first sexual intercourse among youth in cape town, south africa. *International Family Planning Perspectives*, 33(3):98–105. ArticleType: research-article / Full publication date: Sep., 2007 / Copyright © 2007 Guttmacher Institute.

Anglewicz, P. and Clark, S. (2013). The effect of marriage and HIV risks on condom use acceptability in rural malawi. *Social Science & Medicine*, 97:29–40.

Arrow, K. J. (2004). Uncertainty and the welfare economics of medical care. 1963. *Bulletin of the World Health Organization*, 82(2):141–149.

Asiimwe-Okiror, G., Opio, A. A., Musinguzi, J., Madraa, E., Tembo, G., and Caraël, M. (1997). Change in sexual behaviour and decline in HIV infection among young pregnant women in urban uganda. *AIDS (London, England)*, 11(14):1757–1763.

Aspinwall, L. G., Kemeny, M. E., Taylor, S. E., Schneider, S. G., and Dudley, J. P. (1991). Psychosocial predictors of gay men's AIDS risk-reduction behavior. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 10(6):432–444.

Auld, M. C. (2006). Estimating behavioral response to the AIDS epidemic. *The B.E. Journal of Economic Analysis & Policy*, 5(1):1–29.

Ayiga, N. and Letamo, G. (2011). Impact of male circumcision on HIV risk compensation through the impediment of condom use in botswana. *African health sciences*, 11(4):550–559.

Bajos, N., Ducot, B., Spencer, B., and Spira, A. (1997). Sexual risk-taking, socio-sexual biographies and sexual interaction: Elements of the french national survey on sexual behaviour. *Social Science & Medicine*, 44(1):25–40.

Baker, S. A., Morrison, D. M., Gillmore, M. R., and Schock, M. D. (1995). Sexual behaviors, substance use, and condom use in a sexually transmitted disease clinic sample. *The Journal of Sex Research*, 32(1):37–44. ArticleType: research-article / Full publication date: 1995 / Copyright © 1995 Taylor & Francis, Ltd.

Barden-O'Fallon, J. L., deGraft Johnson, J., Bisika, T., Sulzbach, S., Benson, A., and Tsui, A. O. (2004). Factors associated with HIV/AIDS knowledge and risk perception in rural Malawi. *AIDS and behavior*, 8(2):131–140.

Bauch, C. T. and Earn, D. J. D. (2004). Vaccination and the theory of games. *Proceedings of the National Academy of Sciences of the United States of America*, 101(36):13391–13394.

Becker, G. S. and Murphy, K. M. (1988). A theory of rational addiction. *The Journal of Political Economy*, pages 675–700.

Becker, M. H. and Joseph, J. G. (1988). AIDS and behavioral change to reduce risk: a review. *American Journal of Public Health*, 78(4):394–410.

Ben-Zur, H. (2003). Peer risk behavior and denial of HIV/AIDS among adolescents. *Sex Education*, 3(1):75–85.

Ben-Zur, H. and Reshef-Kfir, Y. (2003). Risk taking and coping strategies among israeli adolescents. *Journal of Adolescence*, 26(3):255–265.

Benthin, A., Slovic, P., and Severson, H. (1993). A psychometric study of adolescent risk perception. *Journal of adolescence*, 16(2):153–168.

Biglan, A., Metzler, C. W., Wirt, R., Ary, D., Noell, J., Ochs, L., French, C., and Hood, D. (1990). Social and behavioral factors associated with high-risk sexual behavior among adolescents. *Journal of behavioral medicine*, 13(3):245–261.

Bloom, D. E. and Associates, R. P. (2000). Something to be done: Treating HIV/AIDS. *Science*, 288(5474):2171–2173.

Blower, S. M. and McLean, A. R. (1994). Prophylactic vaccines, risk behavior change, and the probability of eradicating HIV in san francisco. *Science (New York, N.Y.)*, 265(5177):1451–1454.

Bogard, E. and Kuntz, K. M. (2002). The impact of a partially effective HIV vaccine on a population of intravenous drug users in bangkok, thailand: a dynamic model. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 29(2):132–141.

Bonnel (2000). HIV/AIDS: Does it increase or decrease growth in africa?

Booth, R. E., Zhang, Y., and Kwiatkowski, C. F. (1999). The challenge of changing drug and sex risk behaviors of runaway and homeless adolescents. *Child Abuse & Neglect*, 23(12):1295–1306.

Borgdorff, M. W., Barongo, L. R., Newell, J. N., Senkoro, K. P., Devillé, W., Velema, J. P., and Gabone, R. M. (1994). Sexual partner change and condom use among urban factory workers in northwest tanzania. *Genitourinary medicine*, 70(6):378–383.

Boucekkine, R., Desbordes, R., and Latzer, H. (2009). How do epidemics induce behavioral changes? *Journal of Economic Growth*, 14(3):233–264.

Boulle, A., Van Cutsem, G., Hilderbrand, K., Cragg, C., Abrahams, M., Mathee, S., Ford, N., Knight, L., Osler, M., Myers, J., Goemaere, E., Coetzee, D., and Maartens, G. (2010). Seven-year experience of a primary care antiretroviral treatment programme in khayelitsha, south africa. *AIDS (London, England)*, 24(4):563–572.

Brown, E. J. and Van Hook, M. (2006). Risk behavior, perceptions of HIV risk, and risk-reduction behavior among a small group of rural African American women who use drugs. *The Journal of the Association of Nurses in AIDS Care: JANAC*, 17(5):42–50.

Cabieses, B., Ferrer, L., Villarroel, L., Tunstall, H., and Norr, K. (2010). The relationship between knowledge of HIV, self-perceived vulnerability and sexual risk behavior among community clinic workers in chile. *Revista de salud pública (Bogotá, Colombia)*, 12(5):777–789.

Catania, J. A., Coates, T. J., Golden, E., Dolcini, M. M., Peterson, J., Kegeles, S., Siegel, D., and Fullilove, M. T. (1994). Correlates of condom use among black, hispanic, and white heterosexuals in san francisco: the AMEN longitudinal survey. AIDS in multi-ethnic neighborhoods survey. *AIDS education and prevention: official publication of the International Society for AIDS Education*, 6(1):12–26.

Catania, J. A., Coates, T. J., Kegeles, S., Fullilove, M. T., Peterson, J., Marin, B., Siegel, D., and Hulley, S. (1992). Condom use in multi-ethnic neighborhoods of san francisco: the population-based AMEN (AIDS in multi-ethnic neighborhoods) study. *American journal of public health*, 82(2):284–287.

Catania, J. A., Coates, T. J., Peterson, J., Dolcini, M. M., Kegeles, S., Siege, D., Golden, E., and Fullilove, M. T. (1993). Changes in condom use among black, hispanic, and white heterosexuals in san francisco: The AMEN cohort survey. *The Journal of Sex Research*, 30(2):121–128. ArticleType: research-article / Full publication date: May, 1993 / Copyright © 1993 Taylor & Francis, Ltd.

Catania, J. A., Stone, V., Binson, D., and Dolcini, M. M. (1995). Changes in condom use among heterosexuals in wave 3 of the AMEN survey. *The Journal of Sex Research*, 32(3):193–200. ArticleType: research-article / Full publication date: 1995 / Copyright © 1995 Taylor & Francis, Ltd.

Chao, L.-W., Gow, J., Akintola, O., and Pauly, M. (2007). Perceptions of community HIV prevalence, own HIV infection, and condom use among teachers in KwaZulu-natal, south africa. *AIDS and behavior*, 11(3):453–462.

Chelenyane, M. and Endacott, R. (2006). Self-reported infection control practices and perceptions of HIV/AIDS risk amongst emergency department nurses in Botswana. *Accident and Emergency Nursing*, 14(3):148–154.

Cohen, C. R., Montandon, M., Carrico, A. W., Shiboski, S., Bostrom, A., Obure, A., Kwena, Z., Bailey, R. C., Nguti, R., and Bukusi, E. A. (2009). Association of attitudes and beliefs towards antiretroviral therapy with HIV-seroprevalence in the general population of kisumu, kenya. *PLoS ONE*, 4(3).

Cohen, D. J. and Bruce, K. E. (1997). Sex and mortality: Real risk and perceived vulnerability. *The Journal of Sex Research*, 34(3):279–291. ArticleType: research-article / Full publication date: 1997 / Copyright © 1997 Taylor & Francis, Ltd.

Cohen, M. S., McCauley, M., and Gamble, T. R. (2012). HIV treatment as prevention and HPTN 052:. *Current Opinion in HIV and AIDS*, 7(2):99–105.

Crisp, B. R. and Barber, J. G. (1995). The effect of locus of control on the association between risk perception and sexual risk-taking. *Personality and Individual Differences*, 19(6):841–845.

Da Silva, C. G. M., Gonçalves, D. d. A., Pacca, J. C. B., Merchan-Hamann, E., and Hearst, N. (2005). Optimistic perception of HIV/AIDS, unprotected sex and implications for prevention among men who have sex with men, são paulo, brazil. *AIDS (London, England)*, 19 Suppl 4:S31–36.

de Souza, C. T., Bastos, F. I., Lowndes, C. M., Szwarcwald, C. L., dos Santos, E. M., De Castilho, E. A., and Sutmoller, F. (1999). Perception of vulnerability to HIV infection in a cohort of homosexual/bisexual men in Rio de Janeiro, Brazil. Oswaldo Cruz Foundation STD/HIV Prevention Group. *AIDS care*, 11(5):567–579.

Do, M. and Meekers, D. (2009). Multiple sex partners and perceived risk of HIV infection in Zambia: attitudinal determinants and gender differences. *AIDS care*, 21(10):1211–1221.

Dolcini, M. M., Catania, J. A., Coates, T. J., Stall, R., Hudes, E. S., Gagnon, J. H., and Pollack, L. M. (1993). Demographic characteristics of heterosexuals with multiple partners: the national AIDS behavioral surveys. *Family planning perspectives*, 25(5):208–214.

Dudley, C., O'Sullivan, L. F., and Moreau, D. (2002). Does familiarity breed complacency? hiv knowledge, personal contact, and sexual risk behavior of psychiatrically referred latino adolescent girls. *Hispanic Journal of Behavioral Sciences*, 24(3):353–368.

Dupas, P. (2011). Do teenagers respond to HIV risk information? evidence from a field experiment in kenya. *American Economic Journal: Applied Economics*, 3(1):1–34.

Ellen, J. M., Adler, N., Gurvey, J. E., Millstein, S. G., and Tschann, J. (2002). Adolescent condom use and perceptions of risk for sexually transmitted diseases: a prospective study. *Sexually transmitted diseases*, 29(12):756–762.

Ellen, J. M., Boyer, C. B., Tschann, J. M., and Shafer, M. A. (1996). Adolescents' perceived risk for STDs and HIV infection. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 18(3):177–181.

Essien, E., GO, O., D, W., ME, F.-E., CR, S., and L, H. (2008). Injection drug use is associated with HIV risk perception among mexican americans in the rio grande valley of south texas, USA. *Public health*, 122(4):397–403.

Finer, L. B., Darroch, J. E., and Singh, S. (1999). Sexual partnership patterns as a behavioral risk factor for sexually transmitted diseases. *Family Planning Perspectives*, 31(5):228–236. ArticleType: research-article / Full publication date: Sep. - Oct., 1999 / Copyright © 1999 Guttmacher Institute.

Fisher, H. H., Eke, A. N., Cance, J. D., Hawkins, S. R., and Lam, W. K. K. (2008). Correlates of HIV-related risk behaviors in african american adolescents from substance-using families: patterns of adolescent-level factors associated with sexual experience and substance use. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 42(2):161–169.

Flaskerud, J. H., Uman, G., Lara, R., Romero, L., and Taka, K. (1996). Sexual practices, attitudes, and knowledge related to HIV transmission in low income los angeles hispanic women. *The Journal of Sex Research*, 33(4):343–353. ArticleType: research-article / Full publication date: 1996 / Copyright © 1996 Taylor & Francis, Ltd.

Fortenberry, J. D., Tu, W., Harezlak, J., Katz, B. P., and Orr, D. P. (2002). Condom use as a function of time in new and established adolescent sexual relationships. *American Journal of Public Health*, 92(2):211–213.

Francis, A. M. (2008). The economics of sexuality: the effect of HIV/AIDS on homosexual behavior in the united states. *Journal of Health Economics*, 27(3):675–689.

Galavotti, C., Cabral, R. J., Lansky, A., Grimley, D. M., Riley, G. E., and Prochaska, J. O. (1995). Validation of measures of condom and other contraceptive use among women at high risk for HIV infection and unintended pregnancy. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 14(6):570–578.

Gavin, L., Galavotti, C., Dube, H., McNaghten, A., Murwirwa, M., Khan, R., and St. Louis, M. (2006). Factors associated with HIV infection in adolescent females in zimbabwe. *Journal of Adolescent Health*, 39(4):596.e11–596.e18.

Geoffard, P.-Y. and Méchoulan, S. (2004). Comportements sexuels risqués et incitations. *Revue économique*, 55(5):883–899.

Geoffard, P.-Y. and Philipson, T. (1996). Rational epidemics and their public control. *International Economic Review*, 37(3):603–624.

Geoffard, P.-Y. and Philipson, T. (1997). Disease eradication: Private versus public vaccination. *The American Economic Review*, 87(1):222–230.

Gerber, T. P. and Berman, D. (2008). Heterogeneous condom use in contemporary russia. *Studies in Family Planning*, 39(1):1–17.

Geringer, W. M., Marks, S., Allen, W. J., and Armstrong, K. A. (1993). Knowledge, attitudes, and behavior related to condom use and STDs in a high risk population. *The Journal of Sex Research*, 30(1):75–83. ArticleType: research-article / Full publication date: Feb., 1993 / Copyright © 1993 Taylor & Francis, Ltd.

Gerrard, M., Gibbons, F. X., and Bushman, B. J. (1996). Relation between perceived vulnerability to HIV and precautionary sexual behavior. *Psychological bulletin*, 119(3):390–409.

Gersovitz, M. and Hammer, J. S. (2003). Infectious diseases, public policy, and the marriage of economics and epidemiology. *The World Bank Research Observer*, 18(2):129–157. ArticleType: research-article / Full publication date: Autumn, 2003 / Copyright © 2003 Oxford University Press.

Gersovitz, M. and Hammer, J. S. (2004). The economical control of infectious diseases*. *The Economic Journal*, 114(492):1–27.

Gómez, C. A. and Marín, B. V. (1996). Gender, culture, and power: Barriers to HIV-prevention strategies for women. *The Journal of Sex Research*, 33(4):355–362.

Godlonton, S. and Thornton, R. L. (2013). Learning from others' HIV testing: Updating beliefs and responding to risk. *American Economic Review*, 103(3):439–444.

Goldman, J. A. and Harlow, L. L. (1993). Self-perception variables that mediate AIDS-preventive behavior in college students. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 12(6):489–498.

Gorman, B. K. and Bohon, S. A. (2001). HIV testing, perceptions of aids risk, and condom use motivation among US women. *Population Research and Policy Review*, 20(4):321–343. ArticleType: research-article / Full publication date: Aug., 2001 / Copyright © 2001 Springer.

Grappasonni, I., Paci, P., Mazzucchi, F., and Amenta, F. (2011). Survey on HIV risk perception and sexual behaviours among seafarers. *International maritime health*, 62(2):131–137.

Gray, G. E., Metch, B., Churchyard, G., Mlisana, K., Nchabeleng, M., Allen, M., Moodie, Z., Kublin, J., Bekker, L.-G., and HVTN 503 team (2013). Does participation in an HIV vaccine efficacy trial affect risk behaviour in south africa? *Vaccine*, 31(16):2089–2096.

Green, E. C., Halperin, D. T., Nantulya, V., and Hogle, J. A. (2006). Uganda's HIV prevention success: The role of sexual behavior change and the national response. *AIDS and Behavior*, 10(4):335–346.

Gregson, S., Zhuwau, T., Anderson, R. M., and Chandiwana, S. K. (1997). HIV and fertility change in rural zimbabwe. *Health Transition Review*, 7:89–112. ArticleType: research-article / Issue Title: Supplement 2. Evidence of the Socio-demographic Impact of AIDS in Africa / Full publication date: 1997 / Copyright © 1997 National Centre for Epidemiology and Population Health (NCEPH), The Australian National University.

Gregson, S., Zhuwau, T., Anderson, R. M., and Chandiwana, S. K. (1998). Is there evidence for behaviour change in response to AIDS in rural zimbabwe? *Social science & medicine (1982)*, 46(3):321–330.

Gromet, D. M., Ramchand, R., Griffin, B. A., and Morral, A. R. (2010). How perceptions of mortality and HIV morbidity relate to substance abuse problems and risky sexual behaviors among former juvenile offenders. *Health education & behavior: the official publication of the Society for Public Health Education*, 37(6):801–814.

Guiella, G. and Madise, N. J. (2007). HIV/AIDS and sexual-risk behaviors among adolescents: Factors influencing the use of condoms in burkina faso. *African Journal of Reproductive Health / La Revue Africaine de la Santé Reproductive*, 11(3):182–196. ArticleType: research-article / Full publication date: Dec., 2007 / Copyright © 2007 Women's Health and Action Research Centre (WHARC).

Han, L., Lv, F., Xu, P., Zhang, G., Juniper, N. S., and Wu, Z. (2009). Microbicide acceptability among female sex workers in beijing, china: results from a pilot study. *Journal of women's health (2002)*, 18(9):1377–1384.

Hansen, W. B. and Hahn, G. L. (1990). Perceived personal immunity: Beliefs about susceptibility to AIDS. *Journal of Sex Research*, 27(4):622–628.

Hart, G. and Williamson, L. (2005). Increase in HIV sexual risk behaviour in homosexual men in scotland, 1996-2002: prevention failure? *Sexually Transmitted Infections*, 81(5):367–372.

Hingson, R. W., Strunin, L., Berlin, B. M., and Heeren, T. (1990). Beliefs about AIDS, use of alcohol and drugs, and unprotected sex among massachusetts adolescents. *American Journal of Public Health*, 80(3):295–299.

Hoque, Masako, O.-K., Saman, Z., Shahrzad, R., and Masahiro, K. (2009). HIV-related risk behaviours and the correlates among rickshaw pullers of kamrangirchar, dhaka, bangladesh: a cross-sectional study using probability sampling. Technical report.

Iguchi, M. Y., Bux Jr., D. A., Kushner, H., and Lidz, V. (2001). Correlates of HIV risk among female sex partners of injecting drug users in a high-seroprevalence area. *Evaluation and Program Planning*, 24(2):175–185.

Iriyama, S., Nakahara, S., Jimba, M., Ichikawa, M., and Wakai, S. (2007). AIDS health beliefs and intention for sexual abstinence among male adolescent students in kathmandu, nepal: a test of perceived severity and susceptibility. *Public health*, 121(1):64–72.

Jain, A. K., Saggurti, N., Mahapatra, B., Sebastian, M. P., Modugu, H. R., Halli, S. S., and Verma, R. K. (2011). Relationship between reported prior condom use and current self-perceived risk of acquiring HIV among mobile female sex workers in southern India. *BMC Public Health*, 11(Suppl 6):S5.

Jamila K Stockman, S. K. S. (2004). HIV prevention fatigue among high-risk populations in san francisco. *Journal of acquired immune deficiency syndromes (1999)*, 35(4):432–4.

Jiang, J., Huang, J., Yang, X., Ye, L., Wei, B., Deng, W., Wei, S., Qin, B., Upur, H., Zhong, C., Wang, Q., Wang, Q., Ruan, Y., Wei, F., Xu, N., Xie, P., and Liang, H. (2013). Acceptance of male circumcision among male rural-to-urban migrants in western china. *AIDS research and human retroviruses*.

Kabiru, C. W. and Orpinas, P. (2009). Correlates of condom use among male high school students in nairobi, kenya. *The Journal of school health*, 79(9):425–432.

Kalichman, S. C., Hunter, T. L., and Kelly, J. A. (1992). Perceptions of AIDS susceptibility among minority and nonminority women at risk for HIV infection. *Journal of consulting and clinical psychology*, 60(5):725–732.

Kaplan, W. A., Ritz, L. S., Vitello, M., and Wirtz, V. J. (2012). Policies to promote use of generic medicines in low and middle income countries: a review of published literature, 2000-2010. *Health Policy (Amsterdam, Netherlands)*, 106(3):211–224.

Kelly, J. A., St Lawrence, J. S., Brasfield, T. L., Lemke, A., Amidei, T., Roffman, R. E., Hood, H. V., Smith, J. E., Kilgore, H., and McNeill, Jr, C. (1990). Psychological factors that predict AIDS high-risk versus AIDS precautionary behavior. *Journal of consulting and clinical psychology*, 58(1):117–120.

Kengeya-Kayondo, J. F. and Carpenter, L. M. (1999). Risk perception and HIV-1 prevalence in 15,000 adults in rural south-west Uganda. *AIDS (London, England)*, 13(16):2295–302.

Kibombo, R., Neema, S., and Ahmed, F. H. (2007). Perceptions of risk to HIV infection among adolescents in uganda: Are they related to sexual behaviour? *African journal of reproductive health*, 11(3):168–181.

Klein, H., Elifson, K. W., and Sterk, C. E. (2003). "At risk" women who think that they have no chance of getting HIV: self-assessed perceived risks. *Women & Health*, 38(2):47–63.

Kline, A. and Strickler, J. (1993). Perceptions of risk for AIDS among women in drug treatment. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, 12(4):313–323.

Ku, L., Sonenstein, F. L., and Pleck, J. H. (1994). The dynamics of young men's condom use during and across relationships. *Family Planning Perspectives*, 26(6):246–251. ArticleType: research-article / Full publication date: Nov. - Dec., 1994 / Copyright © 1994 Guttmacher Institute.

Lakdawalla, D., Sood, N., and Goldman, D. (2006). HIV Breakthroughs and Risky Sexual Behavior. *The Quarterly Journal of Economics*, 121(3):1063–1102.

Langer, L. M. and Tubman, J. G. (1997). Risky sexual behavior among substance-abusing adolescents: psychosocial and contextual factors. *The American journal of orthopsychiatry*, 67(2):315–322.

Laraque, D., McLean, D. E., Brown-Peterside, P., Ashton, D., and Diamond, B. (1997). Predictors of reported condom use in central harlem youth as conceptualized by the health belief model. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 21(5):318–327.

Lau, J., Kim, J., Lau, M., and Tsui, H. (2004). HIV related behaviours and attitudes among chinese men who have sex with men in hong kong: a population based study. *Sexually Transmitted Infections*, 80(6):459–465.

Lau, J. T. F., Zhang, J., Yan, H., Lin, C., Choi, K.-C., Wang, Z., Hao, C., Huan, X., and Yang, H. (2011). Acceptability of circumcision as a means of HIV prevention among men who have sex with men in china. *AIDS care*, 23(11):1472–1482.

Leigh, B. C., Temple, M. T., and Trocki, K. F. (1993). The sexual behavior of US adults: results from a national survey. *American Journal of Public Health*, 83(10):1400–1408.

Lieberman, E. S. (2007). Ethnic politics, risk, and policy-making a cross-national statistical analysis of government responses to HIV/AIDS. *Comparative Political Studies*, 40(12):1407–1432.

Lutalo, T., Kidugavu, M., Wawer, M. J., Serwadda, D., Zabin, L. S., and Gray, R. H. (2000). Trends and determinants of contraceptive use in rakai district, uganda, 1995-98. *Studies in family planning*, 31(3):217–227.

MacKellar, D. A., Valleroy, L. A., Secura, G. M., Behel, S., Bingham, T., Celentano, D. D., Koblin, B. A., LaLota, M., Shehan, D., Thiede, H., Torian, L. V., and Young Men's Survey Study Group (2007). Perceptions of lifetime risk and actual risk for acquiring HIV among young men who have sex with men. *AIDS and behavior*, 11(2):263–270.

Magadi, M. A. and Agwanda, A. O. (2010). Investigating the association between HIV/AIDS and recent fertility patterns in kenya. *Social Science & Medicine*, 71(2):335–344.

Magura, S., Shapiro, J. L., and Kang, S. Y. (1994). Condom use among criminally-involved adolescents. *AIDS care*, 6(5):595–603.

Maharaj, P. (2006). Reasons for condom use among young people in KwaZulu-natal: Prevention of HIV, pregnancy or both? *International Family Planning Perspectives*, 32(1):28–34. ArticleType: research-article / Full publication date: Mar., 2006 / Copyright © 2006 Guttmacher Institute.

Maharaj, P. and Cleland, J. (2004). Condom use within marital and cohabiting partnerships in KwaZulu-natal, south africa. *Studies in Family Planning*, 35(2):116–124. ArticleType: research-article / Full publication date: Jun., 2004 / Copyright © 2004 Population Council.

Maharaj, P. and Cleland, J. (2005). Risk perception and condom use among married or cohabiting couples in KwaZulu-natal, south africa. *International family planning perspectives*, 31(1):24–29.

Marin, B. V. and Marin, G. (1992). Predictors of condom accessibility among hispanics in san francisco. *American Journal of Public Health*, 82(4):592–595.

Markosyan, K. M., Babikian, T., DiClemente, R. J., Hirsch, J. S., Grigoryan, S., and del Rio, C. (2007). Correlates of HIV risk and preventive behaviors in armenian female sex workers. *AIDS and behavior*, 11(2):325–334.

Marston, C., Juarez, F., and Izazola, J. A. (2004). Young, unmarried men and sex: Do friends and partners shape risk behaviour? *Culture, Health & Sexuality*, 6(5):411–424. ArticleType: research-article / Full publication date: Sep. - Oct., 2004 / Copyright © 2004 Taylor & Francis, Ltd.

Maswanya, E. S., Moji, K., Horiguchi, I., Nagata, K., Aoyagi, K., Honda, S., and Takemoto, T. (1999). Knowledge, risk perception of AIDS and reported sexual behaviour among students in secondary schools and colleges in tanzania. *Health education research*, 14(2):185–196.

Maticka-Tyndale, E. (1991). Sexual scripts and AIDS prevention: Variations in adherence to safer-sex guidelines by heterosexual adolescents. *The Journal of Sex Research*, 28(1):45–66. ArticleType: research-article / Full publication date: Feb., 1991 / Copyright © 1991 Taylor & Francis, Ltd.

Maticka-Tyndale, E. and Tenkorang, E. Y. (2010). A multi-level model of condom use among male and female upper primary school students in nyanza, kenya. *Social science & medicine (1982)*, 71(3):616–625.

McGrath, N., Eaton, J. W., Bärnighausen, T. W., Tanser, F., and Newell, M.-L. (2013). Sexual behaviour in a rural high HIV prevalence south african community: time trends in the antiretroviral treatment era. *AIDS (London, England)*, 27(15):2461–2470.

McKee, K. J., Marková, I., and Power, K. G. (1995). Concern, perceived risk and attitudes towards HIV/AIDS in Scottish prisons. *AIDS care*, 7(2):159–170.

McKusick, L., Horstman, W., and Coates, T. J. (1985). AIDS and sexual behavior reported by gay men in san francisco. *American Journal of Public Health*, 75(5):493–496.

Medoff (2012). Acquired immune deficiency syndrome, risky sexual behavior and abortion. *Journal of Social Sciences*, 8(2):223–229.

Meekers, D. and Klein, M. (2002). Determinants of condom use among young people in urban cameroon. *Studies in family planning*, 33(4):335–346.

Meekers, D. and Richter, K. (2005). Factors associated with use of the female condom in zimbabwe. *International family planning perspectives*, 31(1):30–37.

Miller, J. R., Short, V. L., Wu, H. M., Waller, K., Mead, P., Kahn, E., Bahn, B. A., Dale, J. W., Nasrullah, M., Walton, S. E., Urdaneta, V., Ostroff, S., and Averhoff, F. (2013). Use of nonpharmaceutical interventions to reduce transmission of 2009 pandemic influenza a (pH1n1) in pennsylvania public schools. *The Journal of school health*, 83(4):281–289.

Mills, B., Reyna, V. F., and Estrada, S. (2008). Explaining contradictory relations between risk perception and risk taking. *Psychological science*, 19(5):429–433.

Millstein, S. G. and Moscicki, A. B. (1995). Sexually-transmitted disease in female adolescents: effects of psychosocial factors and high risk behaviors. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 17(2):83–90.

Minichiello, V., Mariño, R., and Browne, J. (2001). Knowledge, risk perceptions and condom usage in male sex workers from three australian cities. *AIDS care*, 13(3):387–402.

Misovich, S. and Fisher, W. (1996). The perceived AIDS preventative utility of knowing one's partner well. *CHIP Documents*.

Mitchell, M. M. and Latimer, W. W. (2009). Gender differences in high risk sexual behaviors and injection practices associated with perceived HIV risk among injection drug users. *AIDS education and prevention: official publication of the International Society for AIDS Education*, 21(4):384–394.

Moatti, J. P., Bajos, N., Durbec, J. P., Menard, C., and Serrand, C. (1991). Determinants of condom use among french heterosexuals with multiple partners. *American Journal of Public Health*, 81(1):106–109.

Moore, J., Harrison, J. S., Kay, K. L., Deren, S., and Doll, L. S. (1995). Factors associated with hispanic women's HIV-related communication and condom use with male partners. *AIDS care*, 7(4):415–427.

Morfit, N. S. (2011). "AIDS is money": How donor preferences reconfigure local realities. *World Development*, 39(1):64–76.

Muñoz, M., Castellanos, D., and Westacott, R. (2005). Sexual risk behaviour, viral load, and perceptions of HIV transmission among homosexually active latino men: an exploratory study. *AIDS care*, 17(1):33–45.

Murphy, D. A., Rotheram-Borus, M. J., and Reid, H. M. (1998). Adolescent gender differences in HIV-related sexual risk acts, social-cognitive factors and behavioral skills. *Journal of Adolescence*, 21(2):197–208.

Napper, L. E., Fisher, D. G., and Reynolds, G. L. (2012). Development of the perceived risk of HIV scale. *AIDS and behavior*, 16(4):1075–1083.

Njogu, W. and Martin, T. C. (2006). The persisting gap between HIV/AIDS knowledge and risk prevention among kenyan youth. *Genus*, 62(2):135–168. ArticleType: research-article / Full publication date: April - June 2006 / Copyright © 2006 Università degli Studi di Roma "La Sapienza".

Ntaganira, J., Hass, L., Hosner, S., Brown, L., and Mock, N. (2012). Sexual risk behaviors among youth heads of household in gikongoro, south province of rwanda. *BMC Public Health*, 12(1):225.

Ntozi, J. P. and Kirunga, C. T. (1997). HIV/AIDS, change in sexual behaviour and community attitudes in uganda. *Health Transition Review*, 7:157–174. ArticleType: research-article / Issue Title: Supplement. <italic>Vulnerability to HIV Infection and Effects of Aids in Africa and Asia/India</italic> / Full publication date: 1997 / Copyright © 1997 National Centre for Epidemiology and Population Health (NCEPH), The Australian National University.

Nunnenkamp, P. and Öhler, H. (2011). Throwing foreign aid at HIV/AIDS in developing countries: Missing the target? *World Development*, 39(10):1704–1723.

Ober, A. J., Iguchi, M. Y., Weiss, R. E., Gorbach, P. M., Heimer, R., Ouellet, L. J., Shoptaw, S., Anglin, M. D., and Zule, W. A. (2011). The relative role of perceived partner risks in promoting condom use in a three-city sample of high-risk, low-income women. *AIDS and behavior*, 15(7):1347–1358.

Oster, E. (2012). HIV and sexual behavior change: Why not africa? *Journal of Health Economics*, 31(1):35–49.

Over (1992). The macroeconomic impact of AIDS in sub-saharan africa.

Peterson, J. L., Catania, J. A., Dolcini, M. M., and Faigeles, B. (1993). III. multiple sexual partners among blacks in high-risk cities. *Family Planning Perspectives*, 25(6):263–267. ArticleType: research-article / Full publication date: Nov. - Dec., 1993 / Copyright © 1993 Guttmacher Institute.

Philipson, T. (2000). Chapter 33 economic epidemiology and infectious diseases. In Anthony J. Culyer and Joseph P. Newhouse, editor, *Handbook of Health Economics*, volume Volume 1, Part B, pages 1761–1799. Elsevier.

Philipson, T. J. and Posner, R. A. (1993). *Private Choices and Public Health: The AIDS Epidemic in an Economic Perspective*. Harvard University Press.

Pleck, J. H., Sonenstein, F. L., and Ku, L. C. (1991). Adolescent males' condom use: Relationships between perceived cost-benefits and consistency. *Journal of Marriage and Family*, 53(3):733–745. ArticleType: research-article / Full publication date: Aug., 1991 / Copyright © 1991 National Council on Family Relations.

Prata, N., Morris, L., Mazive, E., Vahidnia, F., and Stehr, M. (2006). Relationship between HIV risk perception and condom use: Evidence from a population-based survey in mozambique. *International Family Planning Perspectives*, 32(4):192–200. ArticleType: research-article / Full publication date: Dec., 2006 / Copyright © 2006 Guttmacher Institute.

Puri, M. and Cleland, J. (2006). Sexual behavior and perceived risk of HIV/AIDS among young migrant factory workers in Nepal. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 38(3):237–246.

Raghubir, P. and Menon, G. (1998). AIDS and me, never the twain shall meet: The effects of information accessibility on judgments of risk and advertising effectiveness. *Journal of Consumer Research*, 25(1):52–63. ArticleType: research-article / Full publication date: June 1998 / Copyright © 1998 Journal of Consumer Research, Inc.

Rácz, J., Gyarmathy, V. A., Neaigus, A., and Ujhelyi, E. (2007). Injecting equipment sharing and perception of HIV and hepatitis risk among injecting drug users in budapest. *AIDS care*, 19(1):59–66.

Richard, R. and Van Der Pligt, J. (1991). Factors affecting condom use among adolescents. *Journal of Community & Applied Social Psychology*, 1(2):105–116.

Rimal, R. N., Bose, K., Brown, J., Mkandawire, G., and Folda, L. (2009a). Extending the purview of the risk perception attitude framework: findings from HIV/AIDS prevention research in malawi. *Health communication*, 24(3):210–218.

Rimal, R. N., Brown, J., Mkandawire, G., Folda, L., Böse, K., and Creel, A. H. (2009b). Audience segmentation as a social-marketing tool in health promotion: use of the risk perception attitude framework in HIV prevention in malawi. *American journal of public health*, 99(12):2224–2229.

Rimberg, H. M. and Lewis, R. J. (1994). Older adolescents and AIDS: Correlates of self-reported safer sex practices. *Journal of Research on Adolescence*, 4(3):453–464.

Robertson, A. A., Stein, J. A., and Baird, C. (2006). Gender differences in the prediction of condom use among incarcerated juvenile offenders: testing the information-motivation-behavior skills (IMB) model. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 38(1):18–25.

Robles, R. R., Cancel, L. I., Colón, H. M., Matos, T. D., Freeman, D. H., and Sahai, H. (1995). Prospective effects of perceived risk of developing HIV/AIDS on risk behaviors among injection drug users in puerto rico. *Addiction (Abingdon, England)*, 90(8):1105–1111.

Rosenstock, I. M. (2005). Why people use health services. *The Milbank Quarterly*, 83(4).

Rosenthal, D. A., Hall, C., and Moore, S. M. (1992). AIDS, adolescents, and sexual risk taking: A test of the health belief model. *Australian Psychologist*, 27(3):166–171.

Rowniak, S. (2009). Safe sex fatigue, treatment optimism, and serosorting: new challenges to HIV prevention among men who have sex with men. *The Journal of the Association of Nurses in AIDS Care: JANAC*, 20(1):31–38.

Sabogal, F., Faigeles, B., and Catania, J. A. (1993). II. multiple sexual partners among hispanics in high-risk cities. *Family Planning Perspectives*, 25(6):257–262. ArticleType: research-article / Full publication date: Nov. - Dec., 1993 / Copyright © 1993 Guttmacher Institute.

Savasta, A. M. (2004). HIV: associated transmission risks in older adults–an integrative review of the literature. *The Journal of the Association of Nurses in AIDS Care: JANAC*, 15(1):50–59.

Singer, M., Dai, H., Weeks, M. R., and Malave, D. (1998). AIDS risk perception among women drug users in Hartford, CT. *Women & Health*, 27(1-2):67–85.

Sohn, M. and Jin, K. (1999). AIDS-related perceptions and condom use of prostitutes in korea. *Yonsei medical journal*, 40(1):9–13.

Soskolne, V. and Maayan, S. (1998). Factors associated with nonuse of condoms in heterosexual men and women attending an HIV testing clinic in israel. *Public health reviews*, 26(2):175–187.

St Lawrence, J. S. (1993). African-american adolescents' knowledge, health-related attitudes, sexual behavior, and contraceptive decisions: implications for the prevention of adolescent HIV infection. *Journal of consulting and clinical psychology*, 61(1):104–112.

St Lawrence, J. S., Marx, B. P., Scott, C. P., Uwakwe, C. B., Roberts, A., and Brasfield, T. L. (1995). Cross-cultural comparison of US and nigerian adolescents' HIV-related knowledge, attitudes, and risk behaviour: implications for risk reduction interventions. *AIDS care*, 7(4):449–461.

Stall, R., Coates, T. J., and Hoff, C. (1988). Behavioral risk reduction for HIV infection among gay and bisexual men: A review of results from the united states. *American Psychologist*, 43(11):878–885.

Steers, W. N., Elliott, E., Nemiro, J., Ditman, D., and Oskamp, S. (1996). Health beliefs as predictors of HIV-preventive behavior and ethnic differences in prediction. *The Journal of social psychology*, 136(1):99–110.

Stiffman, A. R., Dore, P., and Cunningham, R. M. (1994). Inner-city youths and condom use: health beliefs, clinic care, welfare, and the HIV epidemic. *Adolescence*, 29(116):805–820.

Stringer, E. M., Sinkala, M., Kumwenda, R., Chapman, V., Mwale, A., Vermund, S. H., Goldenberg, R. L., and Stringer, J. S. A. (2004). Personal risk perception, HIV knowledge and risk avoidance behavior, and their relationships to actual HIV serostatus in an urban African obstetric population. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 35(1):60–66.

Sturdevant, M. S., Belzer, M., Weissman, G., Friedman, L. B., Sarr, M., and Muenz, L. R. (2001). The relationship of unsafe sexual behavior and the characteristics of sexual partners of HIV infected and HIV uninfected adolescent females. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 29(3 Suppl):64–71.

Sutton, S., McVey, D., and Glanz, A. (1999). A comparative test of the theory of reasoned action and the theory of planned behavior in the prediction of condom use intentions in a national sample of english young people. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 18(1):72–81.

Tanfer, K., Grady, W. R., Klepinger, D. H., and Billy, J. O. G. (1993). Condom use among u.s. men, 1991. *Family Planning Perspectives*, 25(2):61–66. ArticleType: research-article / Full publication date: Mar. - Apr., 1993 / Copyright © 1993 Guttmacher Institute.

Temple, M. T. and Leigh, B. C. (1992). Alcohol consumption and unsafe sexual behavior in discrete events. *The Journal of Sex Research*, 29(2):207–219. ArticleType: research-article / Full publication date: May, 1992 / Copyright © 1992 Taylor & Francis, Ltd.

Tenkorang, E. Y., Maticka-Tyndale, E., and Rajulton, F. (2011). A multi-level analysis of risk perception, poverty and sexual risk-taking among young people in cape town, south africa. *Health & Place*, 17(2):525–535.

Tenkorang, E. Y., Rajulton, F., and Maticka-Tyndale, E. (2009). Perceived risks of HIV/AIDS and first sexual intercourse among youth in cape town, south africa. *AIDS and behavior*, 13(2):234–245.

Theodore (2001). HIV-AIDS in the caribbean: Economic issues-impact and investment response.

Thuilliez, J. and Berthélemy, J.-C. (2014). Health and development: A circular causality. *Revue d'économie du développement*, -1(Vol. 28):109–137.

Trani, F., Gnisci, F., Nobile, C. G. A., and Angelillo, I. F. (2005). Adolescents and sexually transmitted infections: knowledge and behaviour in italy. *Journal of paediatrics and child health*, 41(5-6):260–264.

Ueyama, M. and Yamauchi, F. (2009). Marriage Behavior Response to Prime-Age Adult Mortality: Evidence from Malawi. *Demography*, 46(1):43–63.

Ugarte, W. J., Högberg, U., Valladares, E., and Essén, B. (2013). Assessing knowledge, attitudes, and behaviors related to HIV and AIDS in nicaragua: A community-level perspective. *Sexual & Reproductive Healthcare*, (0).

Uitenbroek, D. G. (1994). The relationships between sexual behaviour and health lifestyle. *AIDS care*, 6(2):237–246.

Van der Snoek, E. M., de Wit, J. B. F., Mulder, P. G. H., and van der Meijden, W. I. (2005). Incidence of sexually transmitted diseases and HIV infection related to perceived HIV/AIDS threat since highly active antiretroviral therapy availability in men who have sex with men. *Sexually transmitted diseases*, 32(3):170–175.

Van der Velde, F. W., Hooykaas, C., and van der Joop, P. (1992). Risk perception and behavior: Pessimism, realism, and optimism about aids-related health behavior. *Psychology & Health*, 6(1-2):23–38.

Vanable, P. A., Ostrow, D. G., McKirnan, D. J., Taywaditep, K. J., and Hope, B. A. (2000). Impact of combination therapies on HIV risk perceptions and sexual risk among HIV-positive and HIV-negative gay and bisexual men. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 19(2):134–145.

Wagstaff, D. A., Kelly, J. A., Perry, M. J., Sikkema, K. J., Solomon, L. J., Heckman, T. G., Anderson, E. S., and Group, T. C. H. A. P. S. (1995). Multiple partners, risky partners and HIV risk among low-income urban women. *Family Planning Perspectives*, 27(6):241–245. ArticleType: research-article / Full publication date: Nov. - Dec., 1995 / Copyright © 1995 Guttmacher Institute.

Wang, B., Li, X., Stanton, B., Fang, X., Liang, G., Liu, H., Lin, D., and Yang, H. (2007). Gender differences in HIV-related perceptions, sexual risk behaviors, and history of sexually transmitted diseases among chinese migrants visiting public sexually transmitted disease clinics. *AIDS patient care and STDs*, 21(1):57–68.

Weisman, C. S., Plichta, S., Nathanson, C. A., Ensminger, M., and Robinson, J. C. (1991). Consistency of condom use for disease prevention among adolescent users of oral contraceptives. *Family Planning Perspectives*, 23(2):71–74. ArticleType: research-article / Full publication date: Mar. - Apr., 1991 / Copyright © 1991 Guttmacher Institute.

White, R. C. (2004). Health belief model, condom use and jamaican adolescents. *Social and Economic Studies*, 53(2):155–186. ArticleType: research-article / Full publication date: June 2004 / Copyright © 2004 University of the West Indies.

Wilson, N. L., Xiong, W., and Mattson, C. L. (2014). Is sex like driving? HIV prevention and risk compensation. *Journal of Development Economics*, 106:78–91.

Wim, V. B., Christiana, N., and Marie, L. (2013). Syndemic and other risk factors for unprotected anal intercourse among an online sample of belgian HIV negative men who have sex with men. *AIDS and behavior*.

Wong, C.-y. and Tang, C. S.-k. (2004). Sexual practices and psychosocial correlates of current condom use among chinese gay men in hong kong. *Archives of sexual behavior*, 33(2):159–167.

Wood, E., Li, K., Miller, C. L., Hogg, R. S., Montaner, J. S. G., Schechter, M. T., and Kerr, T. (2005). Baseline self-perceived risk of HIV infection independently predicts the rate of HIV seroconversion in a prospective cohort of injection drug users. *International journal of epidemiology*, 34(1):152–158.

Wulfert, E. and Wan, C. K. (1993). Condom use: a self-efficacy model. *Health psychology: official journal of the Division of Health Psychology, American Psychological Association*, 12(5):346–353.

Young, A. (2007). In sorrow to bring forth children: fertility amidst the plague of HIV. *Journal of Economic Growth*, 12(4):283–327.

Zimmerman, R. S. and Olson, K. (1994). AIDS-related risk behavior and behavior change in a sexually active, heterosexual sample: a test of three models of prevention. *AIDS education and prevention: official publication of the International Society for AIDS Education*, 6(3):189–204.